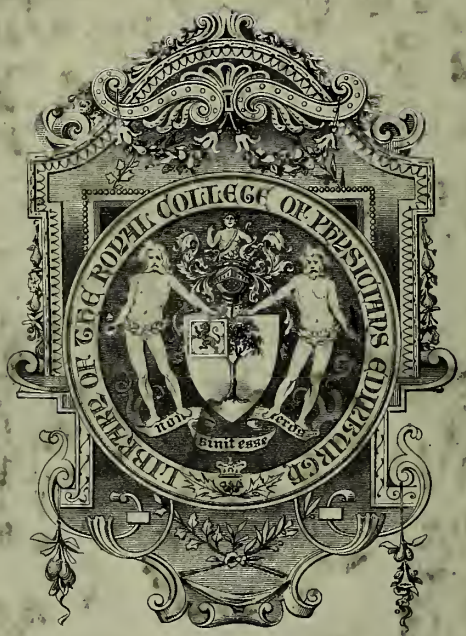


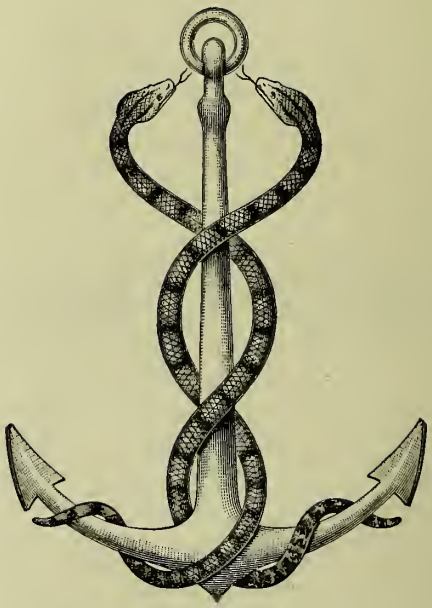

PRESS MARK
Press No. ....T.....
Shelf No. ....7.....
Book No. ..38.....

R.C.P. EDINBURGH LIBRARY

T. 7. 38.

*Pentland's Students' Manuals.*

# MANUAL OF SURGERY



NUNQUAM ALIUD NATURA, ALIUD SAPIENTIA DICIT.

# MANUAL OF SURGERY

BY

ALEXIS THOMSON, F.R.C.S.Ed.

ASSISTANT SURGEON EDINBURGH ROYAL INFIRMARY; SURGEON TO THE DEACONESS HOSPITAL, EDINBURGH

AND

ALEXANDER MILES, F.R.C.S.Ed.

ASSISTANT SURGEON EDINBURGH ROYAL INFIRMARY
SURGEON TO LEITH HOSPITAL




VOLUME FIRST

## GENERAL SURGERY

*SECOND EDITION REVISED AND ENLARGED*
*WITH 313 ILLUSTRATIONS, MOSTLY WOOD ENGRAVINGS*

EDINBURGH AND LONDON
YOUNG J. PENTLAND
1906

EDINBURGH : PRINTED FOR YOUNG J. PENTLAND, 11 TEVIOT PLACE,
AND 21 WARWICK LANE, PATERNOSTER ROW, LONDON, E.C.,
BY R. AND R. CLARK, LIMITED

*All rights reserved*

# PREFACE TO SECOND EDITION.

For the present edition the text has been thoroughly revised and some sections have been re-written. Some of the illustrations of the former edition have been replaced, and a large number of new illustrations have been added, including a series of micro-photographs of the more important bacteria concerned in surgical diseases, presented in the form in which they are met with clinically. For the latter we are indebted to Mr. Richard Muir of the Pathological Department of the University of Edinburgh, and for a number of drawings made from specimens in our own possession we have to thank Mr. Evan O. Bowen. There have also been added characteristic examples of X-ray photographs.

Edinburgh, *October* 1906.

# PREFACE TO FIRST EDITION.

In the preparation of this work we have endeavoured to furnish a systematic view of the present-day aspects of Surgery in sufficient detail to render it useful to the practitioner, without at the same time carrying it beyond the scope appropriate to a Manual for Students.

We have curtailed as far as possible the discussion of theoretical and debatable matter, and have only described pathological processes in so far as they bear directly on diagnosis and treatment. We have not considered it advisable to describe or illustrate histological appearances, as these are more appropriately dealt with in a textbook of Pathology.

The descriptions of the Injuries and Diseases of individual tissues and organs have been arranged with a view to facilitate clinical study, and with the same object a brief résumé has been given of the Surgical Anatomy of the tissue or region concerned.

With a few exceptions the illustrations are original, and appear in these pages for the first time. To our colleagues in the Edinburgh School, and to our other friends who have so generously aided us in this matter, we desire here to tender our sincere thanks.

We would also acknowledge our indebtedness to Sir William Turner for permission to photograph specimens in the Anatomical Museum of the University of Edinburgh; and to the Museum Committee of the Royal College of Surgeons of Edinburgh for a similar privilege. Those illustrations not otherwise acknowledged

are from drawings or photographs in our own collections. We have not considered it necessary to introduce illustrations of surgical instruments.

Our thanks are due to Dr. Logan Turner for his contributions on the affections of the Ear, Nose, and Larynx; and to Dr. Thomas D. Luke for the section on Anæsthetics.

EDINBURGH, *January* 1904.

# CONTENTS.


CHAPTER I.

PAGE

REPAIR . . . . . 1

CHAPTER II.

CONDITIONS WHICH INTERFERE WITH REPAIR . . . 9

CHAPTER III.

METHODS OF WOUND TREATMENT . . . . 29

CHAPTER IV.

INFLAMMATION . . . . . 40

CHAPTER V.

SUPPURATION . . . . . 50

CHAPTER VI.

ULCERATION AND ULCERS . . . . . 72

CHAPTER VII.

GANGRENE . . . . . 93

CHAPTER VIII.

PAGE

Bacterial and other Wound Infections . . . 113

CHAPTER IX.

Tuberculosis . . . . . 139

CHAPTER X.

Syphilis . . . . . 154

CHAPTER XI.

Tumours . . . . . 186

CHAPTER XII.

Injuries . . . . . 216

CHAPTER XIII.

Constitutional Effects of Injuries . . . . 241

CHAPTER XIV.

The Blood-Vessels . . . . . 249

CHAPTER XV.

The Lymphatics . . . . . 310

CHAPTER XVI.

The Nerves . . . . . 328

CHAPTER XVII.

PAGE

THE SKIN AND SUBCUTANEOUS TISSUE . . . . . 356

CHAPTER XVIII.

THE MUSCLES, TENDONS, AND TENDON SHEATHS . . 379

CHAPTER XIX.

THE BURSÆ . . . . . 395

CHAPTER XX.

INJURIES OF BONES . . . . . 401

CHAPTER XXI.

INJURIES OF JOINTS . . . . . 430

CHAPTER XXII.

INJURIES IN THE REGION OF THE SHOULDER AND UPPER ARM 441

CHAPTER XXIII.

INJURIES IN THE REGION OF THE ELBOW AND FOREARM . 472

CHAPTER XXIV.

INJURIES IN THE REGION OF THE WRIST AND HAND . . 494

CHAPTER XXV.

INJURIES IN THE REGION OF THE PELVIS, HIP, AND THIGH . 511

## CHAPTER XXVI.

PAGE
Injuries in the Region of the Knee and Leg . . 539

## CHAPTER XXVII.

Injuries in the Region of the Ankle and Foot . . 565

## CHAPTER XXVIII.

Diseases of Bone . . . . . 578

## CHAPTER XXIX.

Diseases of Joints . . . . . 634

## CHAPTER XXX.

Diseases of Individual Joints . . . . 679

## CHAPTER XXXI.

The Deformities of the Extremities . . . 717

INDEX . . . . . 773

# LIST OF ILLUSTRATIONS.


| FIG. | | PAGE |
|---|---|---|
| 1. | Staphylococcus aureus in Pus from case of Osteomyelitis, | 17 |
| 2. | Streptococci in Pus from case of Diffuse Cellulitis, | 18 |
| 3. | Bacillus coli communis in Pus from Abdominal Abscess, | 19 |
| 4. | Fraenkel's Pneumococci in Pus from Empyema following Pneumonia, | 20 |
| 5. | Charts of Acute Sapræmia, | 24 |
| 6. | Chart of Hectic Fever, | 25 |
| 7. | Chart of Erysipelas occurring in a wound, | 25 |
| 8. | Chart of Pyæmia, | 26 |
| 9. | Chart of Pyæmia, | 26 |
| 10. | Chart of case of Septicæmia followed by Pyæmia, | 27 |
| 11. | Charts of Pyrexia in Head Injuries, | 27 |
| 12. | Charts of Aseptic Fever, | 28 |
| 13. | Diagram of various forms of Whitlow, | 60 |
| 14. | Whitlow in Sheath of Flexor Tendon of Index-Finger, | 61 |
| 15. | Extreme Emaciation accompanying Hectic Fever, | 67 |
| 16. | Chronic Ulcer of Leg, | 75 |
| 17. | Trophic Ulcers of Fingers, | 76 |
| 18. | Perforating Ulcer on the Foot, | 77 |
| 19. | Syphilitic Ulcers of Leg, | 79 |
| 20. | Tibia and Fibula, illustrating the Changes associated with Chronic Ulcer of the Leg, | 81 |
| 21. | Dry Gangrene of Skin after Amputation, | 96 |
| 22. | Carbolic Gangrene, | 98 |
| 23. | Senile Gangrene, | 100 |
| 24. | Diabetic Gangrene of Skin, | 102 |
| 25. | Diabetic Gangrene, | 103 |
| 26. | Bed-sore following Injury of Spine, | 110 |
| 27. | Pressure Bed-sore, | 111 |
| 28. | Bacillus of Tetanus, | 119 |
| 29. | Bacillus of Anthrax, | 127 |
| 30. | Malignant pustule in Neck, | 128 |

| FIG. | | PAGE |
|---|---|---|
| 31. | Chronic Glanders, | 132 |
| 32. | Colony of Actinomyces, | 134 |
| 33. | Mycetoma, or Madura Foot, | 136 |
| 34. | Tubercle bacilli, | 140 |
| 35. | Spirochæta pallida, | 155 |
| 36. | Primary Lesion of Syphilis on Knuckle, | 160 |
| 37. | Tertiary Syphilitic Ulceration in region of Knee and on both Thumbs, | 174 |
| 38. | Facies of Inherited Syphilis, | 179 |
| 39. | Condylomata of Anus in an Infant the subject of Inherited Syphilis, | 180 |
| 40. | Bossing of Skull of Infant in Inherited Syphilis, | 180 |
| 41. | Showing appearance of Permanent Teeth in case of Inherited Syphilis, | 182 |
| 42. | Subcutaneous Lipoma, | 190 |
| 43. | Diffuse Lipomatosis of Neck, | 191 |
| 44. | Chondroma growing from Infra-Spinous Fossa of Scapula, | 192 |
| 45. | Cancellous Osteoma of Lower End of Femur, | 193 |
| 46. | Fibro-myoma of Uterus, | 197 |
| 47. | Papilloma of the Vulva, | 202 |
| 48. | Squamous Epithelioma of the Scalp, | 206 |
| 49. | Dermoid Cyst of Ovary, | 209 |
| 50 | Carpal Ganglion in a woman æt. 25, | 213 |
| 51. | Continuous Suture. Button Sutures, | 220 |
| 52. | Continuous Sutures: Glover's Stitch; Blanket or Button-hole Stitch, | 220 |
| 53. | Interrupted Sutures. Two wide Sutures of Relaxation, | 220 |
| 54. | Burn of Fourth Degree, | 234 |
| 55. | Cicatricial Contraction following Severe Burn, | 236 |
| 56. | Cicatricial Contraction after Burn, | 237 |
| 57. | Genealogical Tree of Hæmophilic Family, | 267 |
| 58. | Extensive Subcutaneous Effusion in case of Hæmophilia, | 268 |
| 59. | Resected portion of Varicose Vein, | 276 |
| 60. | Extensive Varix of Internal Saphena System on Left Leg, | 277 |
| 61. | Varix of Internal Saphena Vein, | 279 |
| 62. | Mixed Nævus of Nose, | 282 |
| 63. | Large Mixed Nævus of Cheek, | 283 |
| 64. | Electrolysis of Nævus under Chloroform Anæsthesia, | 284 |
| 65. | Sacculated Aneurysm of Abdominal Aorta, | 289 |
| 66. | Traumatic Aneurysm of Brachial Artery, | 299 |
| 67. | Diagram of Aneurysmal Varix, | 300 |
| 68. | Diagram of Varicose Aneurysm, | 300 |
| 69. | Congenital Cystic Tumour or Hygroma of Axilla, | 316 |
| 70. | Hodgkin's Disease in a boy æt. 5, | 324 |
| 71. | Stump Neuromata of Sciatic Nerve, | 330 |

FIG. PAGE

72. Diffuse Enlargement of Nerves in generalised Neuro Fibromatosis. (After R. W. Smith), . . . . 340
73. Plexiform Neuroma of small Sciatic Nerve, . . . 341
74. Multiple Neuro-Fibromata of Skin (Molluscum fibrosum). (After von Recklinghausen), . . . . 342
75. Drop-Wrist from Musculo-Spiral Paralysis, . . . 345
76. To illustrate the Loss of Sensation produced by Division of the Median Nerve. (After Head and Sherren), . 347
77. Claw-hand following Division of Ulnar Nerve above Wrist, 347
78. To illustrate Loss of Sensation produced by Complete Division of Ulnar Nerve. (After Head and Sherren), . 348
79. Elephantiasis of Penis and Scrotum, . . . 365
80. Lupus Elephantiasis, . . . . . 366
81. Multiple Sebaceous Cysts or Wens, . . . . 367
82. Advanced Rodent Cancer, . . . . . 372
83. Rodent Cancer of Inner Canthus, . . . . 372
84. Rodent Cancer with destruction of contents of Orbit, . 373
85. Melanotic Cancer of Sole of Foot, . . . . 374
86. Diffuse Melanotic Cancer of Lymphatics of Skin, . . 374
87. Subungual Exostosis, . . . . . 378
88. Tuberculous Disease of Sheaths of Flexor Tendons, . 393
89. Great Enlargement of the Ischial Bursa, . . . 398
90. Bilateral Hydrops of Subcrural Bursæ, . . . 398
91. Hydrops of Prepatellar Bursa, . . . . 399
92. Enlarged Semi-Membranosus Bursa, . . . 399
93. Gouty Disease of Bursæ, . . . . . 400
94. Multiple Fracture of Tibia and Oblique Fracture of Fibula, 406
95. Spiral Fracture of Humerus, . . . . 406
96. Oblique Fracture of Upper Third of Tibia, . . . 407
97. Showing various Fractures of Tibia and Fibula, . . 407
98. Gooch Splint, . . . . . 416
99. Complete Separation of Epiphysis, . . . . 422
100. Partial Separation of Epiphysis, with Fracture running into Diaphysis, . . . . . 422
101. Partial Separation with Fracture of Epiphysis, . . 422
102. Complete Separation with Fracture of Epiphysis, . . 422
103. Radiogram of Fracture of Ulna, two months after injury, to show Callus, . . . . . 425
104. Excessive Callus Formation after Septic Compound Fracture of both Bones of Forearm, . . . . 426
105. Recent Oblique Fracture of Left Clavicle in Middle Third, 442
106. Fracture of Outer End of Clavicle, . . . . 444
107. Fracture of Inner End of Clavicle, . . . . 444
108. Duncan's Modification of Sayre's Method of treating Fracture of Clavicle, . . . . . 446

FIG. PAGE

109. Attitudes of Limb according to Displacement in Chiene's Method of treating Fracture of Clavicle, . . . 447
110. Chiene's Method of treating Fracture of Clavicle, . . 448
111. Dislocation of Acromial End of Left Clavicle upwards, . 449
112. Forward Dislocation of Sternal End of Right Clavicle, . 450
113. Treatment of Upward Dislocation of Acromial End of Clavicle, 451
114. Diagram of most common varieties of Dislocation of the Shoulder, . . . . . 452
115. Sub-coracoid Dislocation of Left Shoulder, . . . 453
116. Kocher's Method of reducing Sub-coracoid Dislocation—First Movement, . . . . . 454
117. Kocher's Method—Second Movement, . . . 456
118. Kocher's Method—Third Movement, . . . 456
119. Miller's Method of reducing Sub-coracoid Dislocation—Second Movement, . . . . . 457
120. Sling and Poroplastic Shoulder-Cap applied for Fracture of Surgical Neck of Humerus, . . . . 465
121. Chiene's Bandage for Fracture of Surgical Neck of Humerus, 466
122. Weight Extension applied for Oblique Fracture of Surgical Neck of Humerus, . . . . . 466
123. Wedge-shaped Splint of Poroplastic for treatment of Fractures at Upper End of Humerus in abducted position, 467
124. Upper Epiphysis of Humerus. (After Poland), . . 467
125. Shortening of Upper Arm from Injury to Upper Epiphysis in Childhood, . . . . . 468
126. Gooch Splints for Fracture of Shaft of Humerus; and rectangular splint to secure elbow, . . . 470
127. Inter-condylar Fracture of Lower End of Humerus, . 474
128. Complete Separation of Lower Epiphysis of Humerus, . 475
129. Partial Separation of Lower End of Humerus with Fracture of Diaphysis, . . . . . 475
130. Cubitus Varus of Left Arm, . . . . . 476
131. Cubitus Valgus of Right Arm, . . . . 476
132. T-shaped Fracture of Olecranon Process, . . . 479
133. Radiogram of Fracture of Olecranon Process, . . 479
134. Gooch Splint for Fracture of Olecranon, . . . 480
135. Horseshoe-shaped Adhesive Plaster, with Elastic Tubing for Fracture of Olecranon, . . . . 480
136. Anterior Splint for Fracture of Olecranon, . . . 480
137. Fracture of Coronoid Process, . . . . 481
138. Backward Dislocation of Elbow, . . . . 482
139. Radiogram of Complete Backward Dislocation of Elbow, . 483
140. Backward and Outward Dislocation of Bones of Forearm, . 484
141. Forward Dislocation of Head of Radius, with Fracture of Upper Third of Shaft of Ulna, . . . . 486

FIG. PAGE
142. Radiogram of Forward Dislocation of Radius, . 487
143. Greenstick Fracture of both Bones of the Forearm, . . 490
144. Gooch Splints for Fracture of both Bones of Forearm, . 491
145. Splints applied for Fracture of Forearm, . . . 491
146. Badly united Fracture of both Bones of Forearm, . . 492
147. Colles' Fracture, . . . . . 495
148. Radiogram of Colles' Fracture, . . . . 495
149. Colles' Fracture, . . . . . 496
150. Colles' Fracture, . . . . . 497
151. Smith's Fracture of Radius, . . . . . 498
152. Section of lower end of Radius and Ulna to show line of Epiphyses. (After Poland), . . . . 499
153. Backward Dislocation of Wrist, . . . . 501
154. Treatment of Fracture of Metacarpals by Pad in the Palm and "Closed-Fist" Bandage, . . . . 504
155. Extension applied for Oblique Fracture of Metacarpal, . 504
156. Radiogram of Bennett's Fracture of Base of Metacarpal of Left Thumb, . . . . . 505
157. Splint for Fracture of Base of Metacarpal of Thumb, . 506
158. Splint applied as used by Bennett. Poroplastic Moulded Splint for Bennett's Fracture, . . . . 506
159. Tracing of Radiogram of Fracture of Second Phalanx of Little Finger, . . . . . 507
160. Backward Dislocation of Metacarpo-Phalangeal Joint of Thumb, . . . . . 508
161. Reduction of Dislocation of Thumb with aid of "Indian Puzzle," . . . . . 508
162. To illustrate Method of dividing the Glenoid Ligament by Subcutaneous Operation, . . . . . 509
163. Fracture of Pelvis through Horizontal and Descending Rami of Pubes, . . . . . 512
164. Many-tailed Bandage and Binder for Fracture of Pelvic Girdle, 513
165. Longitudinal Fracture of Sacrum, . . . . 515
166. Nélaton's Line, . . . . . 516
167. Bryant's Lines, . . . . . 517
168. Section through Hip-Joint, to show epiphyses at upper end of femur, and their relation to the joint. (After Poland), 518
169. Fracture of Neck of Femur, . . . . . 519
170. Fracture of Neck of Femur, . . . . . 520
171. Fracture of Neck of Right Femur showing deformity, . 520
172. Fracture of Narrow Part of Neck of Femur, showing absorption, 522
173. Extension by Weight and Pulley, . . . . 523
174. Long Splint with Extension Plasters applied for Fracture of Neck of Femur, . . . . . 524
175. Long Splint with Perineal Band, . . . . 525

FIG. PAGE
176. Fracture through Base of Neck of Femur with Impaction into the Trochanters, . . . . . 526
177. Non-Impacted Fracture through Base of Neck of Femur, showing alteration of angle of neck, . . . 526
178. Fracture of Femur just below the Small Trochanter united, 528
179. Adjustable Double-inclined Plane, . . . . . 529
180. Hodgen's Splint, . . . . . 529
181. Diagram of the most common Dislocations of the Hip, . 530
182. Dislocation on to Dorsum Ilii, . . . . . 531
183. Dislocation of Femur on to Dorsum Ilii, showing deformity, 532
184. Dislocation into the vicinity of the Ischiatic Notch, . 532
185. Longitudinal Section of Femur showing Recent Fracture of Shaft with overriding of Fragments, . . . 536
186. Local Gooch Splints applied for Fracture of Shaft of Femur, 537
187. Fracture of Thigh treated by Vertical Extension, . . 538
188. Section of Knee-Joint showing extent of Synovial Cavity. (After Braune), . . . . . 540
189. Separation of Lower Epiphysis of Femur. (After Poland), 541
190. Separation of Lower Epiphysis of Femur, . . . 542
191. Separation of Upper Epiphysis of Tibia, . . . 545
192. Separation and Displacement of Upper Epiphysis of Tibia, 545
193. Forward Dislocation of Knee, . . . . 546
194. Backward Dislocation of Knee, . . . . 546
195. Displacement of Internal Semilunar Cartilage towards the Centre of the Joint, . . . . . 549
196. Longitudinal Tear of Internal Semilunar Cartilage, . 551
197. Radiogram of Fracture of Patella, . . . . 554
198. Fracture of Patella, showing separation of fragments, . 555
199. Treatment of Fracture of Patella by means of Inclined Plane and Elastic Extension, . . . . 556
200. Old-standing Fracture of Patella, . . . . 557
201. Vertical Dislocation of Patella, . . . . 558
202. Transverse Fracture of both Bones of Leg, . . . 560
203. Oblique Fracture of both Bones of Leg, . . . 560
204. Recent Fracture of both Bones of Leg, . . . 561
205. Box Splint for Fractures of Bones of Leg, . . . 562
206. A Badly-united Fracture of both Bones of Leg, . . 563
207. Section through Ankle-joint, showing relation of Epiphyses to Synovial Cavity. (After Poland), . . . 566
208. Diagram of Pott's Fracture from behind. (After Helferich), 567
209. Pott's Fracture of Left Ankle, . . . . 567
210. Ambulant Splint of Plaster of Paris, . . . 568
211. Dupuytren's Splint applied to correct Eversion of Foot, . 569
212. Syme's Horse-shoe Splint applied to correct backward displacement of foot, . . . . . 570

FIG. PAGE
213. Converse of Pott's Fracture, . . . . . 571
214. Partial Separation of Lower Epiphysis of Left Tibia outward, 571
215. Ankylosis of Ankle after Compound Fracture with Lateral Dislocation of Ankle, . . . . . 574
216. Compound Dislocation of the Astragalus, . . . 575
217. Acute Suppurative Periostitis of Humerus, . . . 584
218. Shaft of the Tibia after Acute Osteomyelitis, . . 589
219. Large Sequestrum of Lower Part of Shaft of Femur partly surrounded by New Bone, . . . . 590
220. Enlargement of Upper End of Tibia from an Abscess in the Interior, . . . . . 594
221. New Periosteal Bone on Surface of Femur from Amputation Stump, . . . . . 597
222. Sequestrum of Femur after amputation, . . . 598
223. Enlargement of Lower End of Humerus and Upper End of Ulna, the result of tuberculous osteomyelitis, . . 600
224. The Metatarsal and Phalangeal Bones of a Great Toe, showing destructive changes in tuberculous dactylitis, . 601
225. Tuberculous Dactylitis, . . . . . 601
226. Tuberculous Dactylitis, . . . . . 602
227. Shortening of Middle Finger of Adult, the result of tuberculous dactylitis in childhood, . . . . 603
228. Advanced Tuberculous Disease in region of Ankle, . . 603
229. Syphilitic Disease of Skull, . . . . . 605
230. Gummatous Disease of Tibia, . . . . 606
231. Syphilitic Hyperostosis and Sclerosis of Tibia, . . 606
232. Gummatous Disease of Tibiæ, . . . . 607
233. Skeleton of Rickety Dwarf, . . . . . 612
234. Changes in the Skull resulting from Ostitis Deformans, . 618
235. Cadaver, illustrating the alterations in the Lower Limbs resulting from Ostitis Deformans, . . . . 618
236. Multiple Chondromata of Bones of Hand, . . . 624
237. Chondroma of Femur, . . . . . 625
238. Myeloma of Head of Tibia, . . . . . 626
239. The Femur of a boy æt. 12, showing the Bony Shell of a large Cyst-like Cavity which communicates with the interior of the bone, . . . . . 626
240. Periosteal Sarcoma of Head of Fibula, . . . 627
241. Central Sarcoma of Lower End of Femur, . . . 627
242. Periosteal Sarcoma of Tibia, . . . . . 628
243. Osseous Ankylosis of Femur and Tibia in position of flexion, 636
244. Osseous Ankylosis of Knee in the flexed position following upon Tuberculous Arthritis, . . . . 637
245. Section of Upper End of Fibula, showing easeating focus in marrow, erupting on articular surface and infecting joint, 646

| FIG. | | PAGE |
|---|---|---|
| 246. | Gouty Arthritis of Joints of Fingers with chalk stones, | 662 |
| 247. | Arthritis Deformans of Elbow, | 664 |
| 248. | Arthritis Deformans of Knee, | 665 |
| 249. | Hypertrophied Fringes of Synovial Membrane in Arthritis Deformans of Knee, | 665 |
| 250. | Arthritis Deformans of Hands, | 666 |
| 251. | Arthritis Deformans affecting several Joints, | 668 |
| 252. | Bones of Knee-joint in advanced stage of Charcot's Disease, | 670 |
| 253. | Charcot's Disease of Left Knee, | 671 |
| 254. | Melon-seed Bodies from Tuberculous Knee-joint, | 675 |
| 255. | Loose Bodies from Knee-joint, consisting of cartilage and bone, | 676 |
| 256. | Loose Body from Knee-joint, | 677 |
| 257. | Arthropathy of Shoulder in Syringomyelia, | 681 |
| 258. | Diffuse Tuberculous Thickening of Synovial Membrane of Elbow (white swelling), | 682 |
| 259. | Advanced Tuberculous Disease of Acetabulum with caries and perforation into pelvis, | 686 |
| 260. | Early Tuberculous Disease of Right Hip-joint, | 688 |
| 261. | Disease of Left Hip, | 689 |
| 262. | Disease of Left Hip, | 690 |
| 263. | Advanced Tuberculous Disease of Left Hip-joint, | 691 |
| 264. | Advanced Tuberculous Disease of Right Hip-joint, | 692 |
| 265. | Thomas' Hip-Splint applied, | 697 |
| 266. | Upper End of Femur in advanced Arthritis Deformans of Hip, | 702 |
| 267. | Upper End of Femur in advanced Arthritis Deformans of Hip, | 702 |
| 268. | Bilateral Charcot's Disease of Hip, | 703 |
| 269. | Tuberculous Synovial Membrane of Knee, | 705 |
| 270. | Lower End of Femur from an advanced case of Tuberculous Arthritis of the Knee, | 706 |
| 271. | Tuberculous Hydrops of Knee, | 707 |
| 272. | Thomas' Knee-Splint applied, | 711 |
| 273. | Tuberculous Disease of Synovial Membrane of Left Ankle, | 714 |
| 274. | Radiogram of Congenital Dislocation of Hip, | 719 |
| 275. | Congenital Dislocation of Right Hip, | 721 |
| 276. | Congenital Dislocation of Right Hip, | 721 |
| 277. | Limb fixed in Plaster of Paris, after reduction of congenital dislocation by manipulation, | 723 |
| 278. | Contracture Deformities of Upper and Lower Limbs resulting from spastic cerebral palsy in infancy, | 725 |
| 279. | Coxa Vara, | 726 |
| 280. | Bilateral Coxa Vara, | 726 |
| 281. | Eversion of Lower Limbs in Rickety Child, the subject of Coxa Vara, | 728 |

FIG. PAGE
282. Outward Dislocation of Patellæ, . . . . 729
283. Genu Recurvatum, . . . . . 730
284. Spastic Paralysis of both Lower Limbs, . . . 731
285. Diagrams of Genu Valgum and Genu Varum, . . 732
286. Skiagram of Bones of Knee from case of Genu Valgum, . 733
287. Knock-knee in Child, the subject of Rickets, . . 734
288. Bow-knee in Rickety Child, . . . . . 736
289. Bow-leg in Rickety Child, . . . . . 737
290. Congenital Talipes Equino-varus in Infant, . . . 740
291. Congenital Talipes Equino-varus in Adult, . . . 742
292. Infantile Paralysis of Right Lower Extremity, . . 745
293. Bilateral Pes Equinus, result of Spastic Paralysis, . . 746
294. Extreme Form of Pes Equinus, result of Infantile Paralysis, 746
295. Skeleton of Foot from case of Pes Equinus, . . . 747
296. Pes Calcaneo-valgus with excessive arching of foot, . 749
297. Pes Cavus in association with Pes Equinus, . . 749
298. Adolescent Flat-foot, . . . . . 751
299. Imprint of Normal and of Flat Foot, . . . 752
300. Bilateral Pes Valgus, . . . . . 755
301. Double Hallux Valgus, . . . . . 757
302. Bones of Foot showing Hallux Valgus, . . . 757
303. Hallux Rigidus and Flexus, . . . . . 759
304. Hammer-toe, . . . . . 760
305. Section of Hammer-toe, . . . . . 761
306. Congenital Hypertrophy of Left Lower Extremity, . . 761
307. Winged Scapula, . . . . . 764
308. Club-hand, . . . . . 766
309. Congenital Contraction of Ring and Little Fingers, . 767
310. Dupuytren's Contraction, . . . . . 768
311. Splint used after Operation for Dupuytren's Contraction, . 769
312. Supernumerary Thumb, . . . . . 770
313. Congenital Hypertrophy of Index and Middle Finger, . 771

# MANUAL OF SURGERY

# MANUAL OF SURGERY.

## CHAPTER I.

### REPAIR.

Introduction—The ideal process of repair—Modifications of ideal process —Repair in individual tissues.

#### Introduction.

To prolong human life and to alleviate suffering are the ultimate objects of scientific medicine. The two great branches of the healing art—Medicine and Surgery—are so intimately related to one another that it is impossible to draw a hard and fast line between them. For convenience, however, Surgery may be defined as "the art of treating lesions and malformations of the human body by manual operations, mediate and immediate." In order to apply his art it is essential that the surgeon should be thoroughly conversant with the normal anatomy of the body, and with the various pathological processes to which it is liable. Without this knowledge he is unable to recognise such deviations from the normal as result from mal-development, injury, or disease, or rationally to direct his efforts towards the correction or removal of these. And, further, it is not only necessary that the surgeon should be familiar with the various morbid conditions met with in the body, but he must also understand the methods by which nature brings about the repair of these conditions. For it must never be forgotten that the repair of living tissues is a natural and spontaneous process which tends to go on to perfection, except in so far as it is interfered with by external agencies. The *rôle* of surgery, then, being to correct

or remove such extraneous influences as tend to interfere with natural reparative processes, it is essential that at the outset we should clearly understand the natural process of repair in order that our efforts may be directed in harmony therewith.

## Process of Repair.

**The Ideal Process of Repair: Healing by Primary Union.**—The ideal process of natural repair can best be studied as it occurs in a clean-cut wound of the integument, uncomplicated by loss of tissue or by the presence of foreign substances, and more particularly of disease-producing micro-organisms. Such a wound, in virtue of the absence of organisms, is said to be *aseptic*, and furnishes the most favourable conditions possible for the reparative process.

*Formation of Granulation Tissue.*—The passage of the knife through the tissues is immediately followed by an oozing of blood which soon coagulates on the cut surfaces. In each of the divided vessels a clot forms and extends as far as the nearest collateral branch; and on the surface of the wound there is a microscopic layer of bruised and devitalised tissue. If the wound be now closed, the narrow space between its edges is occupied by blood-clot, which consists of red and white corpuscles mixed with a quantity of fibrin, and which forms a temporary uniting medium between the divided surfaces. Soon the capillaries of the part adjacent to the wound begin to dilate, and to throw out minute buds and fine processes which bridge the gap, and so to form a firmer, but still temporary, connection between the two sides. Each bud begins as a small accumulation of granular protoplasm in the wall of the capillary, which gradually elongates into a filament containing a nucleus. This filament either joins with a neighbouring capillary or with a similar filament, and in time these become hollow and are filled with blood from the vessels which gave them origin. In this way a series of young *capillary loops* is formed, the spaces between which are filled by large, irregular, nucleated cells, derived from the proliferation of the fixed connective-tissue cells of the part, and from the endothelial lining of the newly formed vessels. As these cells are concerned in the production of fibrous tissue they are known as *fibroblasts*. Large multi-nucleated *giant cells* may also be found amongst the fibroblasts, especially if any foreign body, such as a silk ligature, is embedded in the tissues.

*Wandering leucocytes*, too, are present in the spaces between the capillary loops, but take no direct part in the formation of

the new tissue. Their function seems to be the removal of the red corpuscles and fibrin of the original blood-clot, and this performed, they either pass back into the circulation in virtue of their amœboid movement, or are themselves eaten up by the growing fibroblasts.

These young capillary loops, with their supporting cells and fluids, constitute *granulation tissue*, which must be looked upon as the fundamental and invariable basis of all tissue repair.

*Formation of Cicatricial Tissue.*—This temporary granulation tissue subsequently becomes more fibrous and less cellular in character as it is transformed into *young cicatricial or scar tissue.* The fibroblasts become enlarged, rounded, and finally spindle-shaped, and produce a fibrillated substance around them which gradually increases in amount and develops into white fibrous tissue. This fibrous tissue assumes an arrangement depending upon the mechanical pull or pressure which happens to be put upon the part. At the same time the capillaries become narrowed and also less numerous.

While these changes are taking place the surface is being covered over by *epidermis* from the margins of the wound. The cells of the rete Malpighii close to the cut edge sprout on to the surface of the wound, and by their proliferation cover the granulations with a thin pink pellicle. As the epithelium increases in thickness at the periphery it assumes a bluish hue, and eventually the cells become cornified and of a greyish-white colour.

In the more highly vascular parts of the body, such as the face, these reparative processes are completed in from three to five days, while in parts where the vascular anastomosis is less free, for example, on the limbs or trunk, they may occupy from a week to ten days.

In course of time the newly formed connective tissue undergoes *cicatricial contraction* by the diminution in size of the blood-vessels and cells, and by the consolidation of the young white fibrous tissue.

The process of ideal repair being unassociated with inflammation, goes on without any appreciable interference with the general health of the patient. The temperature remains normal; the circulatory, gastro-intestinal, nervous, and other functions are undisturbed; locally, the part is cool, of natural colour, and free from pain.

This natural process of repair has long been known as "healing by first intention." It takes place without artificial aid from the surgeon, so long as the edges of the wound are

in apposition and extraneous sources of irritation are excluded. Its progress is not attended by any of the phenomena of inflammation. It is the type of all reparative processes, the various clinical modifications differing from it only in degree. Reparative processes complicated by extraneous agencies such as sepsis show certain differences which will be considered later.

**Modifications of the Process of Repair.**—*Reunion of Parts entirely Separated from the Body.*—Small portions of tissue, such as the end of a finger, the tip of the nose, or a portion of the external ear, completely separated from the body, if accurately replaced and fixed in position, occasionally adhere by primary union.

*Healing under a Scab.*—When a small superficial wound is exposed to the air, the blood and serum exuded on to its surface sometimes dry and form a hard crust or *scab*, which may serve to protect the surface from external irritation in the same way as would a dry pad of sterilised gauze. Under this scab the formation of granulation tissue, its transformation into cicatricial tissue, and the growth of epithelium on the surface, go on uninterruptedly, until in the course of time the crust separates, leaving a healthy scar.

*Healing by Blood-clot.*—Under many circumstances, such as in subcutaneous wounds, amputation wounds, wounds made in excising tumours or in operating upon bones, it is impossible accurately and completely to approximate the divided surfaces. The result is that the space left becomes filled with blood-clot, which acts as a temporary scaffolding in which granulation tissue is built up. Capillary loops grow into the coagulum, and migrated leucocytes from the adjacent blood-vessels destroy the red corpuscles, and are in turn destroyed by the developing fibroblasts, which by their growth and proliferation fill up the gap with young connective tissue. It will be evident that this process only differs from healing by primary union in the *amount* of blood-clot which is present.

*Repair after Loss or Destruction of Tissue.*—When no attempt towards approximation of the edges of a wound can be made, either because a considerable portion of tissue has been lost, for example, in excising a tumour implicating the skin, or because of the presence in the wound of a foreign body, such as a drainage-tube or a pad of gauze, the healing process is somewhat modified.

A much greater amount of new tissue is required to fill up the gap,—although the process by which this is produced is

essentially the same as in the ideal method of repair—namely, the formation of granulation tissue, and its transformation into young fibrous tissue.

The raw surface is first covered by a layer of coagulated blood and fibrin. An extensive new formation of capillary loops and fibroblasts takes place towards the free surface, and goes on until the gap is filled by a fine velvet-like mass of granulation tissue, and then the process tends to stop. This granulation tissue is gradually replaced by young cicatricial tissue, and the surface is covered by the ingrowth of epithelium from the edges of the skin. This modification of the reparative process can be well studied clinically in a wound which, at the time of the operation, has been packed with gauze. When the plug is introduced the walls of the cavity consist of raw tissue with numerous oozing blood-vessels. On removing the stuffing on the fifth or sixth day, it is found that the surface is covered with minute, red, papillary projections (*granulations*), and that already the cavity has become smaller, having been filled in from below by the granulations. At the edges, too, the epithelium has proliferated and is covering over the newly formed tissue. On subsequently examining the wound at intervals of a few days, it is found that the granulation tissue gradually increases in amount till the gap is completely filled up, and that coincidently the epithelium spreads in and covers over its surface. In course of time the epithelium thickens, and as the granulation tissue is slowly replaced by young cicatricial tissue, which has a peculiar tendency to contract and so to obliterate the blood-vessels in it, the scar which is left becomes smooth, pale, and depressed. This method of healing is sometimes spoken of as "healing by granulation"—although, as we have seen, it is by granulation that all repair takes place.

*Healing by Union of two Granulating Surfaces.*—In widely-gaping wounds closure is sometimes obtained by bringing the two surfaces into apposition after each has become covered with healthy granulations. The exudation on the surfaces causes them to adhere, capillary loops pass from one to the other, and their final fusion takes place by the further development of granulation and cicatricial tissue.

## Repair in Individual Tissues.

The process of repair in general having been studied, it will obviate unnecessary repetition later if the modifications of that process as seen in the regeneration of certain of the individual

tissues be now considered. Nature's efforts are always directed towards effecting a complete and perfect restitution to the normal, but her success varies with the tissue involved and the amount of damage it has sustained. Any given tissue can only be replaced from tissue of a similar kind; but while simple structures such as skin, cartilage, bone, periosteum or tendon, have a high power of regeneration, those of a more complex organisation, such as secreting glands, muscle, and the tissues of the central nervous system, are but imperfectly restored. The peripheral nerves, however, are eminently capable of regeneration.

The elementary basis of all repair is granulation tissue. If any portion of the original structure survive, this granulation tissue is replaced by an imitation of the original tissue, more or less perfect in proportion to the simplicity of its constituent elements. Where the original tissue is completely destroyed, or is of a highly specialised structure, simple cicatricial connective tissue fills the gap, or a cavity containing a turbid fluid may persist.

*Regeneration of Skin and Connective Tissue.*—The mode of regeneration of these tissues has already been described as the type of ideal repair. The more highly organised elements of the skin, such as hair follicles, sweat and sebaceous glands, are imperfectly reproduced; hence a superficial scar remains, smooth, dry, and hairless.

*Regeneration of Epithelium.*—Epithelium is only reproduced from pre-existing epithelium, and, as a rule, from one of a similar type, although metaplastic transformation of cells of one kind of epithelium into another kind can take place. Thus a granulating surface may be covered entirely by the ingrowing of the cutaneous epithelium from the margins; or islets, originating in surviving cells of sebaceous glands or sweat glands, or of hair follicles, may spring up in the centre of the raw area. Such islets may also be due to the accidental transference of loose epithelial cells from the edges. Even the fluid from a blister, in virtue of the isolated cells of the rete Malpighii which it contains, is capable of starting epithelial growth on a granulating surface. Hairs and nails may be completely regenerated if a sufficient amount of the hair follicles or of the nail matrix has escaped destruction. The epithelium of a mucous membrane is regenerated in the same way as that on a cutaneous surface.

Epithelial cells have the power of living for some time after being separated from their normal surroundings, and of growing again when once more placed in favourable circumstances. On this fact the practice of skin-grafting is based.

*Repair of Tendons.*—When a tendon is divided, the end nearer the muscle fibres is drawn away from the other, leaving a gap which is speedily filled by blood-clot. In the course of a few days this clot becomes permeated by granulation tissue, the fibroblasts of which are derived from the sheath of the tendon, the surrounding connective tissue, and probably also from the divided ends of the tendon itself. These fibroblasts ultimately develop into typical tendon cells, and the fibres which they form constitute the new tendon fibres. In the course of this reparative process it is not uncommon for the tendon and its sheath to become adherent, leading to impaired movement and stiffness.

*Repair of Cartilage.*—Solutions in continuity of cartilage are usually repaired by ordinary cicatricial fibrous tissue. This takes place, for example, when a portion of articular cartilage is divided by incision or by a fracture implicating the articular end of a bone.

In other cases, such as in fractures of costal cartilage or of the cartilages of the larynx, the cicatricial tissue is ultimately replaced by bone.

It is, however, possible for a metaplastic transformation of connective-tissue cells into cartilage cells to take place, the characteristic hyaline matrix being secreted by the new cells. This is sometimes observed as an intermediary stage in the healing of fractures, especially in young bones. It may also take place in the regeneration of lost portions of cartilage, provided the new tissue is so situated as to constitute part of a joint and to be subjected to pressure by an opposing cartilaginous surface. This is illustrated by what takes place after excision of joints where it is desired to restore the function of the articulation. By carrying out passive movements between the constituent parts, the fibrous tissue covering the ends of the bones becomes moulded into shape, its cells take on the characters of cartilage cells, and forming a matrix, so develop a new cartilage.

Conversely, it is observed that when articular cartilage is no longer subjected to pressure by an opposing cartilage, it tends to be transformed into fibrous tissue, as may be seen in deformities attended with displacement of articular surfaces, such as hallux valgus and club-foot.

*Repair of Bone.*—The repair of bone is most conveniently considered in relation to fractures, but the steps in the process are practically identical when the bone has been divided in the operation of osteotomy, in resection or excision.

*Repair of Muscle.*—Neither unstriped nor striped muscle seems to be capable of being regenerated to any but a moderate degree. If the ends of a divided muscle be at once brought into apposition by stitches, primary union takes place with a minimum of intervening fibrous tissue. The nuclei of the muscle fibres in close proximity to this young cicatricial tissue proliferate, and a few new muscle fibres may be developed, but any gross loss of muscular tissue is replaced by a fibrous cicatrix. It would appear that portions of muscle transplanted from animals to fill up gaps in human muscle are similarly replaced by fibrous tissue. When a muscle is paralysed from loss of its nerve-supply and undergoes complete degeneration, it is not capable of being regenerated, even should the integrity of the nerve be restored, and so its function is permanently lost.

The *Repair of Blood-vessels* is described at p. 255.

*Regeneration of Secretory Glands.*—The regeneration of secretory glands, such as the salivary glands, liver, and kidney, is usually incomplete. The greater part of a gap left in such organs is filled by cicatricial tissue, but in some—for example, the liver and kidney — the epithelial cells of the remaining glandular tissue proliferate, and a certain degree of regeneration takes place.

*Regeneration of Intestine and other Composite Structures.*—Composite structures like the intestine, the œsophagus, the bladder, or the urethra, are repaired by the formation of cicatricial tissue, each constituent element behaving after the manner of its kind. Thus the muscular and glandular tissues are not reproduced, while the fibrous, vascular, and lining epithelial elements are.

*Regeneration of Nerve Tissues.* — There is no trustworthy evidence that regeneration of the tissues of the brain or spinal cord in man ever takes place. Any loss of substance is replaced by cicatricial tissue.

*The Regeneration of Peripheral Nerves* is described at page 329.

# CHAPTER II.

## CONDITIONS WHICH INTERFERE WITH REPAIR.

Want of rest—Irritation—Unhealthy tissues—Pathogenic bacteria. Surgical Bacteriology—Introduction—General characters of bacteria—Classification of bacteria—Conditions of bacterial life—Pathogenic powers of bacteria—Results of bacterial growth—Death of bacteria—Immunity—Antitoxic sera—Bacteriological diagnosis—Pyogenic bacteria. Leucocytosis. The Temperature in Surgical Diseases.

The general process of ideal repair, and its modifications in the regeneration of the different tissues which have been studied, are liable to be interrupted or completely arrested by various extraneous influences which it is the duty of the surgeon to prevent or remove.

Of such conditions the first is *Want of Rest.* "The first and great requisite for the restoration of injured parts is rest," said John Hunter; and physiological and mechanical rest as the chief of natural therapeutic agents was the theme of John Hilton's classical work. By "rest," in this connection, is meant not merely a state of physical repose, but in addition as complete cessation of all physiological and mechanical function as is possible. A tuberculous joint, for example, must be enclosed in splints in such a way as to prevent all movement of its constituent bones. An inflamed eye must be protected from the light, in addition to having its movements arrested. To enable the small, painful ulcer of the mucous membrane of the anus, known as anal fissure, to heal, it is not only necessary to prevent the mechanical stretching of the part due to the periodic movement of the bowels, but the persistent contractions of the underlying sphincter muscle must be arrested by stretching or cutting its fibres.

Another fertile source of interference with repair in surgical wounds is *irritation*, either by mechanical agents such as rough,

unsuitable dressings, bandages, or ill-fitting splints; or by chemical agents in the form of strong lotions or other applications.

An *unhealthy or devitalised condition of the patient's tissues* also hinders the reparative process. Bruised or lacerated skin heals less kindly than skin cut with a smooth, sharp instrument; and persistent venous congestion of a part, such as occurs in the leg when the veins are varicose, tends to delay the healing of open wounds. The existence of grave constitutional disease, such as Bright's disease, diabetes, syphilis, scurvy, or alcoholism, also impedes healing.

Infection by disease-producing micro-organisms, or *pathogenic bacteria*, is, however, the most potent factor in disturbing the natural process of repair in surgical wounds.

## Surgical Bacteriology.

Within recent years the whole science of pathology has been revolutionised by the knowledge which has accumulated regarding the nature of micro-organisms, and their relation to disease. So much has bacteriology come to dominate every department of surgery in particular, that it is now the standpoint from which nearly all surgical questions have to be considered. In no department of medical science has so much progress been made, or such a wealth of information and literature arisen, in a corresponding period of time. It is therefore necessary that we should here confine our attention to such aspects of the subject as have a direct surgical bearing.

The term *sepsis* as now used in clinical surgery no longer retains its original meaning as synonymous with "putrefaction," but is used to denote all conditions in which bacterial infection has taken place, and more particularly those in which pyogenic bacteria are present. In the same way the term *aseptic* conveys the idea of freedom from all forms of bacteria, putrefactive or otherwise; and the term *antiseptic* is used to denote a power of counteracting bacteria and their products.

**General Characters of Bacteria.**—The term *bacteria* is employed in a generic sense to include all the forms of minute vegetative organisms of which the science of bacteriology treats, and is to be accepted as synonymous with such terms as micro-organisms, microbes, or germs.

A *bacterium* consists of a finely granular mass of protoplasm, enclosed in a thin gelatinous envelope. Many forms are motile —some in virtue of fine thread-like flagella, and others through contractility of their protoplasm. The great majority multiply

by simple fission, each parent cell giving rise to two daughter cells, and this process goes on with such extraordinary rapidity that it has been computed that in twenty-four hours from one individual bacterium seventeen millions of similar cells may be produced. Other varieties are propagated by the formation of *spores*, but as most spore-forming bacteria give rise to only one spore, this is rather a process of rejuvenescence than of multiplication. A spore is a minute mass of protoplasm surrounded by a dense, tough membrane, developed in the interior of the parent cell. Spores are remarkable for their tenacity of life, and for the resistance they offer to the action of heat and chemical germicides.

Bacteria are most conveniently classified according to their shapes. Thus we recognise (1) those which are globular—*cocci*; (2) those which resemble a rod—*bacilli*.

*Cocci or micrococci* are minute round bodies, averaging 1 to 1·5 mm. in diameter. They all multiply by fission, and when they divide in such a way that the resulting cells remain in pairs, they are called *diplococci*, of which the bacteria of gonorrhœa and pneumonia are examples (Fig. 4). When they divide irregularly and form grape-like bunches they are known as *staphylococci*, and to this variety the commonest pyogenic or pus-forming organisms belong (Fig. 1). When division takes place only in one axis, so that long chains are formed, the term *streptococcus* is applied (Fig. 2). Streptococci are met with in erysipelas and various other inflammatory and suppurative processes of a spreading character.

*Bacilli* are rod-shaped bacteria, usually at least twice as long as they are broad. Some multiply by fission, others by sporulation. Tuberculosis, tetanus, anthrax, and many other surgical diseases are due to different forms of bacilli (Figs. 28, 29, 34).

**Conditions of Bacterial Life.**—The first essential to the growth and development of bacteria is a suitable food-supply in the form of proteids and carbohydrates, which complex organic substances they break up, in the act of nourishing themselves, into simpler elements. An alkaline medium favours bacterial growth; and moisture is a necessary condition, although spores can survive the want of water for much longer periods than fully developed bacteria. The necessity for oxygen varies in different species. Those which, like the bacillus proteus vulgaris, can only flourish in its presence are known as *aërobic bacilli*, or *aërobes*; those, such as the bacillus of tetanus and of malignant œdema, which will not live in the presence of oxygen, are spoken of as *anaërobic*. The great majority of bacteria, how-

ever, while they prefer oxygen, are able to live without it, and are called *facultative anaërobes.*

A temperature ranging from 95° to 102° F. is the most suitable for bacterial life. Extreme or prolonged cold paralyses but does not kill micro-organisms. Few, however, survive being raised to a temperature of 134½° F. Boiling for ten to twenty minutes will kill not only bacteria, but even their most resistant spores. Direct sunlight, electric light, or even diffuse daylight is inimical to the growth of bacteria.

**Pathogenic Properties of Bacteria.**—We are now only concerned with pathogenic bacteria—that is, bacteria capable of producing disease in the human subject. This capacity depends upon two sets of factors—(1) certain features peculiar to the invading bacteria, and (2) others peculiar to the host. Many bacteria have only the power of living upon dead matter, and are known as *saprophytes.* Such as do flourish in living tissue are, by distinction, known as *parasites.* The power a given parasitic micro-organism has of multiplying in the body and giving rise to disease is spoken of as its *virulence*, and this varies not only with different species, but in the same species at different times and under varying circumstances. The actual number of organisms introduced is also an important factor in determining their pathogenic power. Healthy tissues can resist the invasion of a certain number of bacteria of a given species; but when that number is exceeded, the organisms get the upper hand and disease results. It is also the case that if organisms gain access directly to the blood-stream they produce their effects more certainly and with greater intensity than when they are introduced into the tissues.

Further, the virulence of an organism is modified by the condition of the patient into whose tissues it is introduced. So long as a person is in robust health the tissues are able to resist the attacks of moderate numbers of most bacteria. Any lowering of the vitality of the individual, however, either locally or generally, at once renders him more susceptible to infection. Thus bruised or torn tissue is much more liable to infection with pus-producing organisms than tissues clean-cut with a knife; also, after certain diseases, the liability to infection by the organisms of diphtheria, pneumonia, or erysipelas is much increased. Even such slight depression of vitality as results from bodily fatigue, or exposure to cold and damp, may be sufficient to turn the scale in the battle between the tissues and the bacteria. Age is an important factor in regard to the action of certain bacteria. Young subjects are attacked by diphtheria,

tuberculosis, acute osteomyelitis, and some other diseases with greater frequency and severity than those of more advanced years.

In different races, localities, environments, and seasons, the pathogenic powers of certain organisms, such as those of erysipelas, diphtheria, and acute osteomyelitis, vary considerably.

There is evidence for the statement that a *mixed infection*—that is, the introduction of more than one species of organism, for example, the tubercle bacillus and a pyogenic staphylococcus—increases the severity of the resulting disease. Even if one of the varieties gain the ascendancy, the poisons produced by the others so devitalise the tissue cells, and diminish their power of resistance, that the virulence of the most active organism is increased. On the other hand, there is reason to believe that the products of certain organisms antagonise one another—for example, an attack of erysipelas may effect the cure of a patch of tuberculous lupus.

Lastly, it is not uncommon for micrococci and bacilli to invade the internal organs by the blood-stream in enormous numbers and with great rapidity during the period of extreme debility which shortly precedes death.

**Results of Bacterial Growth.**—Some organisms, such as those of tetanus and erysipelas, and certain of the pyogenic bacteria, show little tendency to pass beyond the point at which they gain an entrance to the body. Others, on the contrary,—for example, the tubercle bacillus and the organism of acute osteomyelitis,—although frequently remaining localised to the seat of inoculation, tend to pass to distant parts, lodging in the capillaries of joints, bones, kidney, or lungs, and there producing their deleterious effects.

Multiplication in the blood-stream does not occur to any great extent in the human subject.

It is by the vital changes they bring about in the parts where they settle that micro-organisms disturb the health of the patient. In deriving their nourishment from the complex organic compounds in which they flourish, the organisms evolve, probably by means of a ferment, certain chemical products in the form of albumoses, peptones, alcohols, ethers, and acids; as well as certain gases, such as sulphuretted hydrogen, carbonic acid, and marsh gas. These, and probably other more complex substances, the constitution of which is as yet unknown, are generically known as *toxins*. When these poisons are absorbed into the general circulation of the patient, they give rise to certain groups of symptoms—such as rise of temperature, associated circulatory

and respiratory derangements, interference with the gastro-intestinal functions and also with those of the nervous system—which go to make up the condition known as blood-poisoning, toxæmia, or *bacterial intoxication.* In addition to this, certain bacteria produce toxins which give rise to definite and distinct groups of symptoms—such as the convulsions of tetanus, or the paralyses which follow diphtheria.

Local lesions also, of an inflammatory, suppurative, or ulcerative character, result from the action of certain organisms and their products, as in tuberculosis, typhoid, anthrax, and diphtheria.

*Death of Bacteria.* — Under certain circumstances it would appear that the accumulation of the toxic products of bacterial action tends to interfere with the continued life and growth of the organisms themselves, and in this way the natural cure of certain diseases is brought about. Outside the body bacteria may be killed by starvation, by want of moisture, by being subjected to high temperature, and by the action of certain chemical agents, of which carbolic acid and the perchloride and biniodide of mercury are the most powerful.

**Immunity.**—It has long been known that some persons are insusceptible to infection by certain diseases, from which they are said to enjoy a *natural immunity.* It is also well established in the case of many acute diseases—it is probably true of all—that one attack protects the patient, for a time at least, from a second attack. This is known as an *acquired immunity.* Within recent years numerous attempts have been made to arrive at an understanding of the processes by which immunity is acquired, and as a result of many brilliant researches, notably those of Metchnikoff and of Ehrlich, much light has been thrown on this difficult problem. According to Metchnikoff the chief *rôle* in the production of immunity is played by the leucocytes, which, as Leber has shown, exhibit a peculiar biological or chemical attraction towards bacteria, which is termed *chemotaxis.* Under the influence of this chemotactic attraction, and in virtue of their amœboid movement, the leucocytes approach the bacteria, and after ingesting them, destroy them by a process akin to digestion. To this process Metchnikoff applied the name *phagocytosis*, and he showed that the most active agents engaged in it are the polynuclear leucocytes, which he terms *microphages.*

The large lymphocytes of the blood—the *macrophages*—show less bactericidal tendencies and are engaged chiefly in destroying other tissue cells, such as red blood corpuscles and connective-tissue cells.

As originally enunciated, Metchnikoff's theory of phagocytosis was not sufficient to prove the predominance of the leucocytes in the production of immunity, particularly in view of the fact that the ingestion process was found to go on most actively in immunised animals. Additional support has been given to his view, however, by the experiments of Buchner, which show that, as a necessary preliminary to phagocytosis, an extra-cellular influence is exerted on the bacteria by certain nucleo-proteids, of the nature of enzymes—termed *alexins*—which are the secretory product of living leucocytes.

The most recent investigations seem to indicate that it is by the combined action of alexins and of phagocytes that the tissues are enabled to resist and overcome the attacks of pathogenic bacteria. There is also reason to believe that as a result of these biological processes certain antitoxic bodies are elaborated in the blood, and that it is on the presence of these that immunity depends. Ehrlich's investigations have been directed towards elucidating the chemical processes by which these antitoxins are produced, and by which they neutralise the toxins, but his theory of immunity is too complicated to be discussed here. Suffice it to say that the mode of action of antitoxins appears to be a purely chemical one, the antitoxin uniting with its specific toxin, and producing a compound which has no poisonous properties.

Certain highly useful and practical conclusions have been arrived at as a result of these investigations. The chief of these is that immunity from certain diseases may be produced by artificial inoculation with the products of the organisms which cause them.

*Artificial immunity* may be induced in one of two ways—(*a*) by injecting into an animal a series of non-lethal doses of an organism or its toxins; or (*b*) by injecting the serum of an animal highly immunised by the previous method. The latter is the principle on which the modern antitoxin method of treatment is based, and it may act either against specific toxins, as in the case of the anti-diphtheric and the anti-tetanus sera (*antitoxic sera*), or against specific organisms, as in the anti-streptococcic serum (*anti-microbic sera*).

The *antitoxic sera* are produced by a process of which the following are the essential steps:—(1) a powerful toxin is obtained from artificial cultures of a highly virulent organism. (2) The power of this toxin is estimated by experimental injections into animals of known weight, until a standard of toxicity is obtained; (3) a large animal—for example, the horse—after

being rendered immune by gradually increasing doses of this toxin, is bled aseptically, and the serum after separating is ready for use, 0·5 per cent. of carbolic acid being added to prevent decomposition. (4) By experiments on animals the immunising value ("unit of immunity") of this serum is then obtained, and the clinical dose determined.

*Clinical Use of Antitoxic Sera.*—Each antitoxic serum has its own appropriate dose depending upon the value of its unit of immunity. Every precaution must be taken to prevent organismal contamination of the serum or of the apparatus by means of which it is injected. Syringes are so made that they can be sterilised by boiling. The best situations for injection are under the skin of the abdomen, the thorax, or the buttock, and the skin at the seat of puncture should be purified. If the bulk of the full dose is large, it should be divided and injected into different parts of the body, not more than 20 c.c. being injected at one place.

**Bacteriological Diagnosis.**—For purposes of diagnosis various facts regarding the morphology and life-history of bacteria are made use of. Thus by means of the microscope the general histological characters may be studied after staining with certain aniline dyes. Again, different organisms vary in their behaviour on such artificial culture-media as gelatin, agar-agar, bouillon, potato, etc., with regard to the rapidity and direction of growth; the colour and smell of the growing colonies; and the effect these have upon the medium in which they grow, some species evolving gases, others changing the chemical reaction of the medium. Variations also occur depending on the temperature at which the organisms are incubated, the presence or absence of oxygen, and other like conditions. Lastly, by inoculation in animals of different species and in different tissues, information valuable for the purpose of diagnosis may be obtained.

### Pyogenic Bacteria.

From the point of view of the surgeon the most important varieties of micro-organisms are those which cause inflammation and suppuration—the *pyogenic bacteria.* This group includes a great many species, and these are so widely distributed that they are to be met with under all conditions of everyday life.

The nature of the inflammatory and suppurative processes will be considered in detail later; suffice it here to say that

they are brought about by the action of one or other of the organisms which we have now to consider.

It is found that the *staphylococci*, which cluster into groups, tend to produce localised lesions; while the chain-forms—*streptococci*—give rise to diffuse, spreading conditions. Many varieties of pyogenic bacteria have now been differentiated, the best known being the staphylococcus aureus, the streptococcus, and the bacillus coli communis.

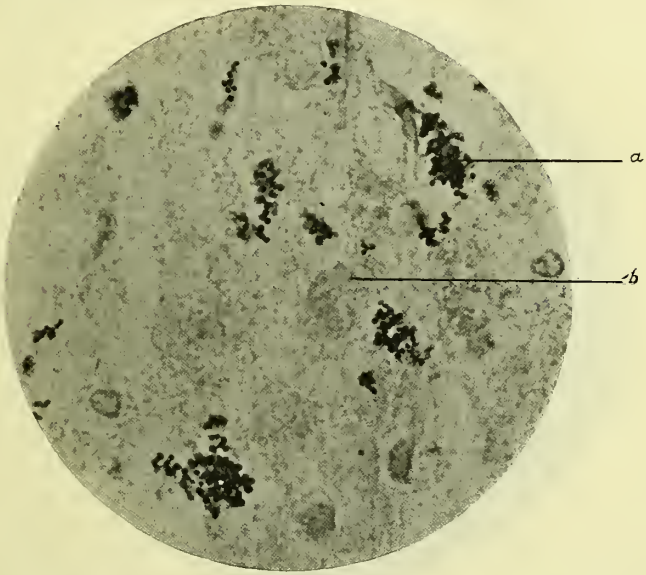



FIG. 1.—Staphylococcus aureus in Pus from case of Osteomyelitis. × 1000 diam.

*a* = Masses of staphylococci. *b* = Altered and degenerated pus cells.

*Staphylococcus Aureus.*—This is the commonest organism found in localised inflammatory and suppurative conditions. It varies greatly in its virulence, and is found in such widely different conditions as skin pustules, boils, carbuncles, and some acute inflammations of bone. As seen by the microscope it occurs in grape-like clusters, fission of the individual cells taking place irregularly (Fig. 1). It grows very readily in artificial media, such as agar, on the surface of which it forms a brilliant orange film, or on gelatin, which it liquefies, the organisms forming an orange-yellow deposit at the bottom of the tube—

hence the term *aureus*. It is of high vitality and resists more prolonged exposure to high temperatures than most non-sporing bacteria. It is capable of lying latent in the tissues for long periods, and of again becoming active and causing a fresh outbreak of suppuration, for example in the marrow of long bones. This organism is widely distributed: it is found on the skin, in the mouth, and in other situations in the body, and it occurs in all situations where dust is present.




FIG. 2.—Streptococci in Pus from case of Diffuse Cellulitis. ×1000 diam.
*a* = Chains of streptococci. *b* = Pus cells.

The other pyogenic staphylococci are of less importance. The *staphylococcus albus* is much less common than the aureus, but has the same properties and characters, save that its growth on artificial media assumes a white colour. It is the common cause of stitch abscesses, the skin being its normal habitat.

*Streptococcus Pyogenes.*—This organism also varies greatly in its virulence, but the conditions which determine the variations are as yet imperfectly understood. In some instances—for example, in erysipelas—it causes a sharp attack of acute spreading

inflammation, which soon subsides without showing any tendency to end in suppuration; under other conditions it gives rise to a generalised pyæmia which rapidly proves fatal. The organism has less capacity of liquefying the tissues than the staphylococcus, so that pus formation takes place more slowly. At the same time its products are very potent in destroying the tissues in their vicinity, and so interfering with the exudation of leucocytes which would otherwise exercise their protective influence. Streptococci invade the lymph spaces, and are associated with acute

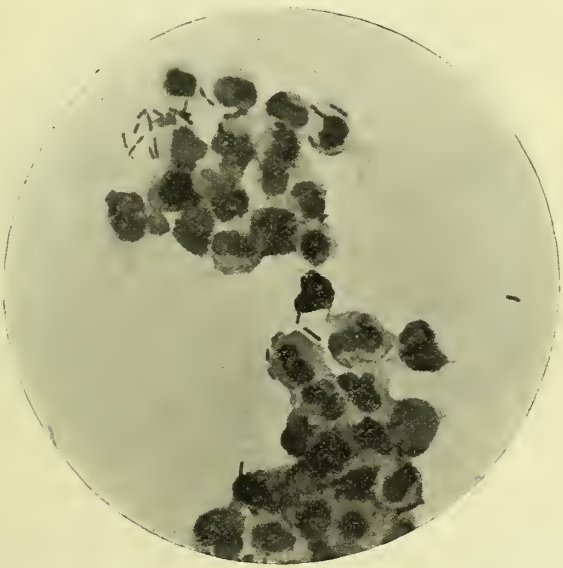


Fig. 3.—Bacillus coli communis in Pus from abdominal abscess. × 1000 diam.

spreading conditions such as phlegmonous or erysipelatous inflammations and suppurations, lymphangitis and suppuration in lymphatic glands, puerperal peritonitis and inflammation of other serous membranes, and inflammations of synovial membranes; also with a form of septic pneumonia which is prone to follow on severe operations in the mouth and throat. Streptococci are also concerned in the production of spreading gangrene and pyæmia.

Division takes place in one axis so that chains of varying length are formed (Fig. 2). It is less easily cultivated in artificial

media than the staphylococcus; it forms a whitish growth and does not liquefy gelatin.

*Bacillus Coli Communis.*—This organism, which is a normal inhabitant of the intestinal tract, shows a great tendency to invade any organ or tissue whose vitality is lowered. It is causally associated with such conditions as peritonitis and peritoneal suppuration resulting from strangulated hernia,

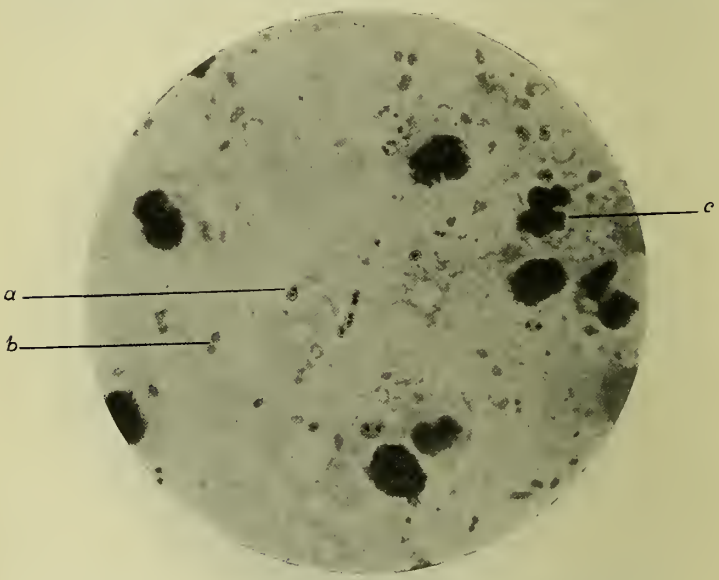



FIG. 4.—Fraenkel's Pneumococci in Pus from Empyema following Pneumonia. ×1000 diam. Stained with Muir's capsule stain.

*a* = Pneumococci with capsule. *b* = Degenerated pneumococci, only the capsule remaining. *c* = Pus cells.

appendicitis, or perforation in any part of the alimentary canal. In cystitis, pyelitis, abscess of the kidney, suppuration in the bile ducts or liver, and in many other abdominal conditions it plays a most important part. The discharge from wounds infected by this organism has usually a very fœtid, or even a fæcal odour, and often contains gases resulting from putrefaction.

It is a small rod-shaped organism with short flagella, which render it motile. It closely resembles the typhoid bacillus, but is distinguished from it by its behaviour in artificial culture media (Fig. 3).

*Pneumo-bacteria.*—Two forms of organism are associated with pneumonia—*Fraenkel's pneumococcus* (one of the diplococci) (Fig. 4) and *Friedländer's pneumo-bacillus* (a short rod-shaped form). One or other of these may be met with in inflammation of the pericardium, the membranes of the brain, the middle ear, or of lymphatic glands, in suppuration in the pleural cavity or in the liver, and various other inflammatory and suppurative conditions. They are most frequently found in company with the ordinary pyogenic bacteria, especially streptococci.

*Bacillus Typhosus.*—This organism has been found in pure culture in suppurative conditions of bone, of cellular tissue, and of internal organs, especially during convalescence from typhoid fever. Like the staphylococcus it is capable of lying latent in the tissues for long periods.

*Other Pyogenic Bacteria.*—It is not necessary to do more than name some of the other organisms which are known to be pyogenic, such as the bacillus pyocyaneus, which is found in green and blue pus; the micrococcus tetragenus; the gonococcus; actinomyces; glanders bacillus, and the tubercle bacillus. Most of these will receive further mention in connection with the diseases to which they give rise.

**Leucocytosis.**—Recent investigations have shown that most bacterial diseases, as well as certain other pathological conditions, are associated with an increase in the number of leucocytes in the blood throughout the entire circulatory system. This condition of the blood, which is known as *leucocytosis*, is believed to be due to an excessive output and rapid formation of leucocytes by the bone marrow, and it probably has as its object the arrest and destruction of the invading organisms or toxins.

The *normal* number of leucocytes per cubic millimetre varies in different individuals, and in the same individual under different conditions, from 5000 to 10,000. It is generally accepted that 7500 is a normal average, and that anything above 12,000 is to be considered as abnormal. When leucocytosis is present the number may range from 12,000 to 30,000 or even higher; 40,000 is looked upon as a high degree of leucocytosis. According to Ehrlich the following may be taken as the standard proportion of the various forms of leucocytes in normal blood: polynuclear neutrophile leucocytes, 70 to 72 per cent.; lymphocytes, 22 to 25 per cent.; eosinophile cells, 2 to 4 per cent.; large mononuclear and transitional leucocytes, 2 to 4 per cent.; mast-cells, 0·5 to 2 per cent.

In estimating the clinical importance of a leucocytosis, it is not sufficient merely to count the aggregate number of leucocytes present. A differential count must be made to determine which variety of cells is in excess. In the majority of surgical affections attended with leucocytosis it is chiefly the granular polymorpho-nuclear neutrophile leucocytes that are in excess (*ordinary leucocytosis*). In some cases, and particularly in parasitic diseases such as trichiniasis and hydatid disease, the eosinophile leucocytes also show a proportionate increase (*eosino-*

*philia*). The term *lymphocytosis* is applied when there is an increase in the number of circulating lymphocytes, as occurs, for example, in lymphatic leukæmia, and in certain cases of syphilis.

Leucocytosis is met with in nearly all the acute infective diseases, such, for example, as erysipelas, diphtheria, pneumonia, and scarlet fever. It is also present in acute pyogenic inflammatory affections, particularly in those attended with suppuration—for example, peritonitis, appendicitis, abscesses in joints and in internal organs. In gangrenous processes also, and in general septic poisonings, such as septicæmia and pyæmia, leucocytosis is present. In some cases of malignant disease the number of leucocytes is increased to 15,000 or 20,000. A few hours after a severe hæmorrhage also there is usually a leucocytosis of from 15,000 to 30,000, which lasts for three or four days (Lyon). In cases of hæmorrhage the leucocytosis is increased by infusion of fluids into the circulation. After all operations there is at least a transient leucocytosis (*post-operative leucocytosis*) (F. I. Dawson).

The degree of leucocytosis is, as a rule, proportionate to the extent of the local lesion, and to the systemic reaction which the local lesion excites. It is to be borne in mind, however, that in very acute septic conditions the extreme virulence of the toxins may prevent the leucocytes reacting, and leucocytosis may be absent. The absence of leucocytosis in a disease in which it is usually present is therefore to be looked upon as a grave omen, particularly when the general symptoms are severe.

The leucocytosis begins soon after the infection manifests itself—for example, by shivering, rigor, or rise of temperature. The number of leucocytes rises somewhat rapidly, increases while the condition is progressing, and remains high during the febrile period, but there is no constant correspondence between the number of leucocytes and the height of the temperature. The arrest of the inflammation and its resolution are accompanied by a fall in the number of leucocytes, while the occurrence of suppuration is attended with a further increase in their number.

In interpreting the "blood count" it is to be kept in mind that a *physiological leucocytosis* occurs within three or four hours of taking a meal, especially one rich in proteids, from 1500 to 2000 being added to the normal number. In *digestion leucocytosis* the increase is chiefly in the polynuclear neutrophile leucocytes. Immediately before and after delivery, particularly in primiparæ, there is usually a moderate degree of leucocytosis. If the labour is normal and the puerperium uncomplicated, the number of leucocytes regains the normal in about a week. Lactation has no appreciable effect on the number of leucocytes. In new-born infants, also, the leucocyte count is abnormally high, ranging from 15,000 to 20,000. In children under one year of age, the normal average is from 10,000 to 20,000.

*Absence of Leucocytosis—Leucopenia.*—In certain infective diseases the number of leucocytes in the circulating blood is abnormally low—3000 or 4000—and this condition is known as *leucopenia*. It occurs in typhoid fever, especially in the later stages of the disease ; in tuberculous lesions—for example, tuberculous peritonitis, pleurisy, ostitis, or periostitis, when unaccompanied by suppuration ; in malaria, and in most cases of uncomplicated influenza. The occurrence of leucocytosis in any of these conditions is to be looked upon as an indication that a mixed infection has taken place, and that some suppurative process is in progress.

The absence of leucocytosis in some cases of virulent septic poisoning has already been referred to.

From what has been said above it will be evident that numerous fallacies have to be guarded against in estimating the clinical importance of leucocytosis, and that too much reliance must not be placed upon a single observation, particularly in emergency cases. Whenever possible a series of observations should be made, the blood being taken about four hours after meals, and about the same hour each day.

The clinical significance of the blood count in individual diseases will be further referred to later.

*The Iodine or Glycogen Reaction.*—The leucocyte count may be supplemented by staining films of the blood with a watery solution of iodine and potassium iodide. In all advancing purulent conditions, in septic poisonings, in pneumonia, and in cancerous growths associated with ulceration, a certain number of the polynuclear leucocytes are stained of a brown or reddish-brown colour, due to the action of the iodine on some substance in the cells of the nature of glycogen. This reaction is absent in serous effusions, in unmixed tuberculous infections, in uncomplicated typhoid, and in the early stages of cancerous growths.

## The Temperature in Surgical Diseases.

It may be convenient here to study some of the variations in temperature met with in different forms of surgical disease.

A marked raising of the general temperature of the body is one of the most constant and important concomitants of all inflammatory affections, and the temperature chart forms a fairly reliable index of the severity of the patient's condition. It is due to the absorption into the circulation of bacterial products which interfere with the special nerve-centres in the medulla that regulate the balance between the production and the loss of body heat.

Clinically the temperature is estimated by means of a self-registering thermometer placed, for from five to ten minutes, in close contact with the skin in the axilla ; or the temperature may be taken in the mouth. Sometimes the thermometer is inserted into the rectum, where, however, the temperature is normally $\frac{3}{4}$° F. higher than in the axilla.

*In health* the temperature of the body is maintained at a mean of about 98·4° F. (37° C.) by the heat-regulating mechanism. The temperature varies from hour to hour even in health. It reaches its maximum between four and eight in the evening, when it may rise to 99° F., and is at its lowest between four and six in the morning, when it may be about 97° F.

On reading and interpreting a temperature chart in disease, therefore, it is necessary to make allowance for this normal variation, and it is interesting to observe in this connection that an hourly chart of a case of acute septic infection runs parallel with the normal curve.

It is also worthy of note that the temperature is much more easily disturbed in children than in adults, and may become markedly elevated (104° or 105° F.) from comparatively slight causes ; while in the aged it is less liable to change, so that in them a rise to 103° or 104° F. is to be looked upon as indicating a high state of fever.

It is rare for a patient to live if the temperature remains for any length of time above 106° F., although some extraordinary cases are on record in which it has reached as high as 116° F. without proving fatal.

A sudden rise of temperature is usually associated with a feeling of chilliness down the back and in the limbs, which may be so marked

that the patient shivers violently, while the skin becomes cold, pale, and shrivelled—*cutis anserina*. This is a nervous reaction due to a want of correspondence between the internal and the surface temperature of the body, and is known clinically as a *rigor*. When the temperature rises gradually the chill is usually very slight and may be unobserved. Even during the cold stage, however, the internal temperature is already raised, and by the time the chill has passed off its maximum has been reached.

These disturbances seem to follow the absorption of toxins into the blood, and to be due to an interference with the central heat-regulating mechanism.

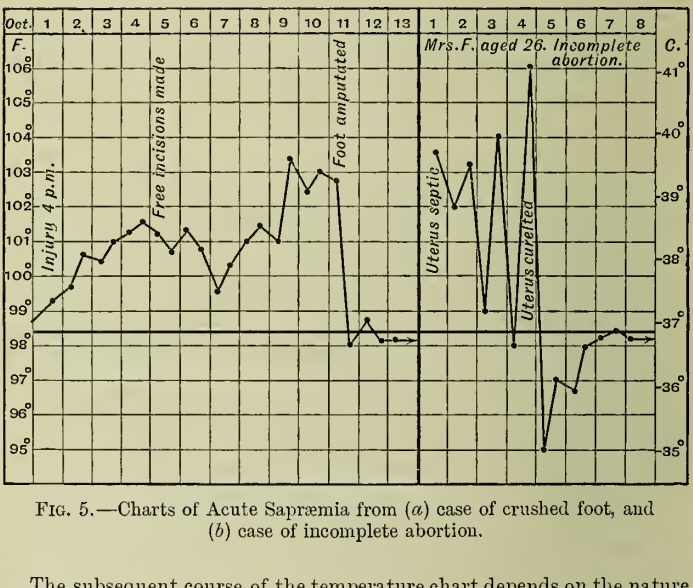



FIG. 5.—Charts of Acute Sapræmia from (*a*) case of crushed foot, and (*b*) case of incomplete abortion.

The subsequent course of the temperature chart depends on the nature and amount of the poison absorbed; whether it is the pure toxin of a single species of organism, or the result of a mixed infection by more than one species; and whether the supply is intermittent or continuous. It follows, therefore, that certain groups of surgical conditions present particular types of temperature curve resembling one another more or less closely.

In *acute sapræmia* (p. 65), for instance, where the patient absorbs from a localised focus of infection a definite quantity of toxin either in a single large dose or in repeated small doses, the temperature rises rapidly, remains up till the poison is excreted, or till the source of its production is removed—for example, by amputation—or by the establishment of drainage, after which it falls again and remains normal (Fig. 5).

The temperature may fall very rapidly and become markedly subnormal (Fig. 5, *b*).

In the condition known as *hectic* (p. 67), which is a form of *chronic*

sapræmia, the temperature chart is characterised by diurnal variations, ranging from 97° F. in the morning to 102° or 103° F. in the evening. The rise usually begins in the afternoon, and the fall takes place suddenly in the early morning, and is accompanied by profuse sweating (Fig. 6).

The same type of temperature curve is met with in cases of *surgical*

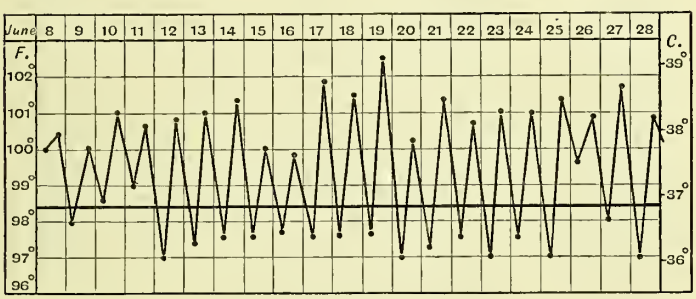



Fig. 6.—Chart of Hectic Fever.

*tuberculosis*, where there is, in all probability, a mixed infection. In these cases the highest temperature may be recorded in the afternoon.

In such conditions as *erysipelas* (p. 113), where a constant supply of toxins is poured into the system, the temperature remains elevated so long as the disease progresses, but falls more or less rapidly whenever its




Fig. 7.—Chart of Erysipelas occurring in a wound.

progress is arrested (Fig. 7). A relapse is at once indicated by a second rise of temperature.

In *septicæmia* (p. 68), organisms as well as toxins enter the circulation, and the temperature charts of this disease vary so widely that it is difficult to determine a type. So long as the disease progresses, the temperature curve is practically the same as that of sapræmia or of

erysipelas; but after it is arrested, the defervescence is more gradual, the temperature taking several days to reach the normal.

In *pyæmia* (p. 69) secondary abscesses develop in different parts of

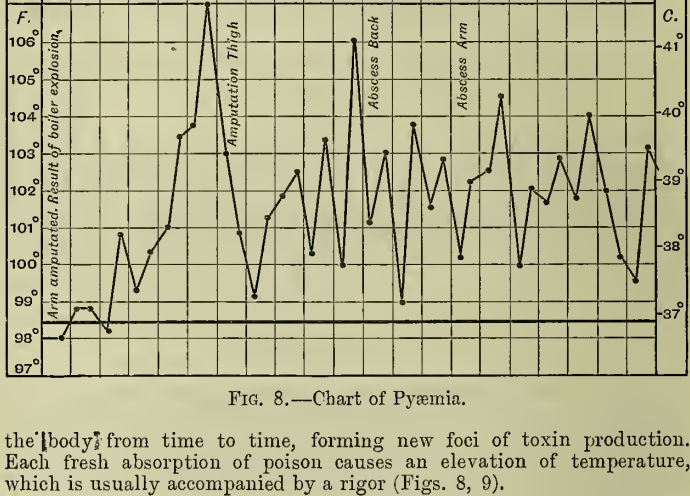



FIG. 8.—Chart of Pyæmia.

the body from time to time, forming new foci of toxin production. Each fresh absorption of poison causes an elevation of temperature, which is usually accompanied by a rigor (Figs. 8, 9).

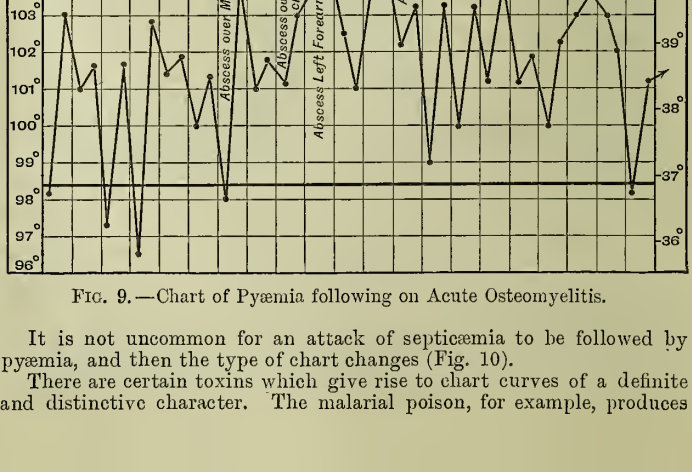



FIG. 9.—Chart of Pyæmia following on Acute Osteomyelitis.

It is not uncommon for an attack of septicæmia to be followed by pyæmia, and then the type of chart changes (Fig. 10).

There are certain toxins which give rise to chart curves of a definite and distinctive character. The malarial poison, for example, produces

a characteristic alteration of temperature, and patients who have once suffered from this disease are liable to marked rises from comparatively

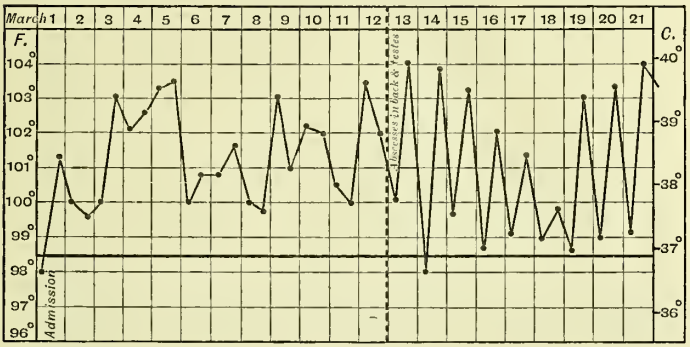



FIG. 10.—Chart of case of Septicæmia followed by Pyæmia.

trivial causes. After minor operations or slight injuries, for instance, a sudden and marked rise may occur and cause needless apprehension

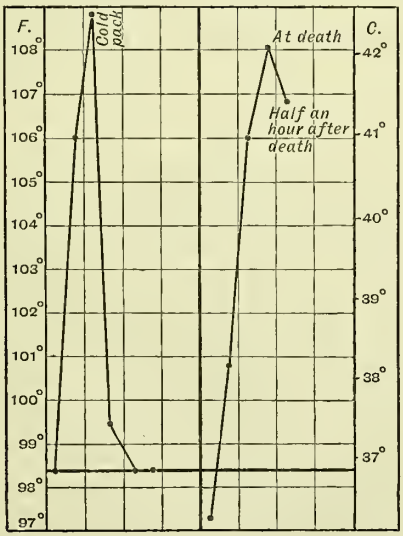



FIG. 11.—Charts of Pyrexia in Head Injuries.

of septic or other complications. The characteristic curves of other diseases also may be modified by the malarial poison.

After injuries or operations on the brain or upper part of the spinal cord sudden and excessive elevation of temperature, unaccompanied by rigors or vascular disturbances of the skin, is not uncommon as a result of direct damage to the central heat-regulating mechanism (Fig. 11).

It is almost needless to add that an elevation of temperature in a surgical patient is not always due to his surgical condition. Constipation, influenza, tonsillitis, injurious pressure by splints, the development of a bed-sore, or some other complication may furnish an explanation.

*Aseptic Fever.*—An elevation of temperature, which is unassociated with the presence of inflammation or its causal bacteria, is frequently observed after surgical operations which have been attended with considerable shock and loss of blood, as well as after injuries attended with extravasation of blood into the tissues—for example, fractures. After a slight initial fall the temperature begins to rise, and in the course of from twelve to sixteen hours reaches 100° or 101° F. It soon declines again, and in from twenty-four to thirty-six hours has regained the

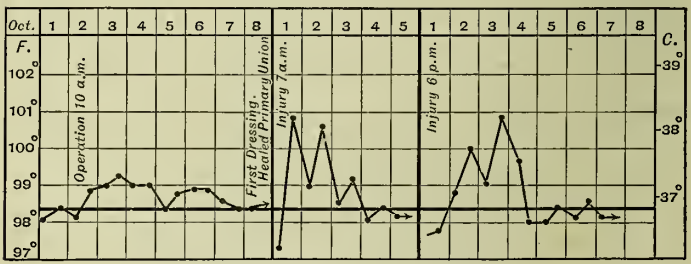



FIG. 12.—Charts of Aseptic Fever.

normal. This rise is not associated with any of the other signs or symptoms of inflammation, and has been called *aseptic fever*, being attributed to the absorption into the circulation of certain of the products of disorganised blood or other disintegrated tissue (Fig. 12).

*Subnormal Temperature* (*Algidity*).—The general temperature of the body may fall below the normal from various causes. In severe railway or machinery accidents, for example, or in perforating wounds or diseases of the abdominal viscera, or, again, during the passage of biliary or urinary calculi, profound and dangerous lowering of the temperature may occur. The same result may follow a sudden and copious loss of blood, profuse diarrhœa, or severe vomiting; and it is a characteristic symptom in patients who are slowly starved, as, for example, in cases of stricture of the œsophagus. In most of these conditions, however, if death does not rapidly ensue, the temperature begins to rise and becomes elevated.

In some cases of extreme sapræmia or septicæmia also the temperature falls instead of rising, and this indicates a very grave prognosis. In cases of cerebral abscess and in some other conditions causing pressure on the brain the temperature remains persistently subnormal.

# CHAPTER III.

## METHODS OF WOUND TREATMENT.

Varieties of wounds—Modes of infection—Lister's work—Means taken to prevent infection of wounds: *heat; chemical antiseptics; disinfection of hands; instruments; ligatures; dressings*—Means taken to combat septic infection: *purification; open-wound method.*

The presence of pyogenic bacteria being the most important factor interfering with the process of repair in wounds, it is necessary that we should now consider the means at our disposal for preventing or counteracting the baneful effects of these organisms.

The surgeon is called upon to treat two distinct classes of wounds: (1) those resulting from injury or disease in which *the skin is already broken*, or in which a communication with a mucous surface exists; and (2) those which he himself makes *through intact skin*, no infected mucous surface being involved.

Infection by bacteria must be assumed to have taken place in all wounds made in any other way than by the knife of the surgeon operating through unbroken skin. On this assumption the modern antiseptic system of wound treatment is based. Pathogenic bacteria are so widely distributed that in the ordinary circumstances of everyday life, no matter how trivial a wound may be, or how short a time it may remain exposed, the access of organisms to it is almost certain, unless definite means are employed to prevent this.

It cannot be emphasised too strongly that rigid antiseptic precautions are to be adopted, not only in dealing with wounds which are free of organisms, but equally in the management of wounds and other lesions which are already infected. Any laxity in our methods which admits of fresh organisms reaching an infected wound adds materially to the severity of the septic process and consequently to the patient's risk.

There are many ways in which accidental infection may occur. Take, for example, the case of a person who receives a cut on the face by being knocked down in a carriage accident on the street. Organisms may be introduced to such a wound from the shaft or wheel by which he was struck, from the ground on which he lay, from any portion of his clothing which may have come in contact with the wound, or from his own skin. Or, again, the hands of those who render first aid, the water used to bathe the wound, the handkerchief or other extemporised dressing applied to it, may be the means of conveying septic infection. Should the wound open on a mucous surface, such as the mouth or nasal cavity, the organisms constantly present in such situations are liable to prove agents of infection.

Even after the patient has come under professional care the risks of his wound becoming infected are not past, because the hands of the surgeon, his instruments, dressings or other appliances may all, unless carefully purified, become the sources of infection.

In the case of an operation carried out through unbroken skin, organisms may be introduced into the wound from the patient's own skin, from the hands of the surgeon or his assistants, through the medium of contaminated instruments, swabs, ligature or suture materials, or other things used in the course of the operation, or from the dressings applied to the wound.

Further, bacteria may gain access to devitalised tissues by way of the blood-stream, being carried hither from some infected area elsewhere in the body.

The sources of wound infection being so numerous, it is little wonder that in former days few wounds of the class now under consideration escaped the ravages of pyogenic or other bacteria, and that inflammation, suppuration, erysipelas, hospital gangrene, and pyæmia were of everyday occurrence in surgical practice.

Those who only know the surgical conditions of to-day find it hard to believe that little more than thirty years ago, in a leading article in the *Lancet*, the writer stated that at that time "the mortality from compound fractures, amputations, and other operations such as lithotomy is something frightful"; that "death from blood poisoning is not confined to cases of serious operations, but happens ever and anon after operations in themselves trivial. It is lamentable," says the writer, "to think of the extent to which the best and most refined surgery of the time is being frustrated, in our great hospitals, and even in those most recently built. The risk of blood poisoning is now the one opprobrium of surgery."

To the genius of Lord Lister we owe it that this opprobrium is now removed. In 1867 he began to put into practice the method he had devised for preventing and counteracting the septic process, which he had convinced himself depended upon the action of bacteria. Carbolic acid was the first antiseptic agent he employed, and by its use in compound fractures he soon obtained results such as had never before been attained. The principle was applied to other conditions with like success, and so profoundly has it affected the whole aspect of surgical pathology that many of the septic diseases with which the older surgeons had to deal are now all but unknown.

**Means taken to prevent Infection of Wounds.**—The avenues by which septic agents may gain access to surgical wounds are so numerous and so wide, that it requires the greatest care and the most watchful attention on the part of the surgeon to guard them all. It is only by constant practice and patient attention to technical details, in the operating-room and at the bedside, that the carrying out of surgical manipulations in such a way as to avoid bacterial infection will become an instinctive act and a second nature. It is only possible here to indicate the chief directions in which danger lies, and to describe the means most generally adopted to meet the danger.

To prevent septic infection it is essential that everything which comes into contact with a wound should be thoroughly sterilised or disinfected. The two chief agencies at our disposal for this purpose are heat and chemical antiseptics.

*Sterilisation by Heat.*—The most reliable, and at the same time the most convenient and generally applicable means of sterilisation is by heat. All bacteria and spores are completely destroyed by being subjected for fifteen minutes to *saturated circulating steam* at a temperature of 130° to 145° C. (= 266° to 293° F.). The articles to be sterilised are enclosed in a perforated tin casket, which is placed in a specially constructed steriliser, such as that of Schimmelbusch. This apparatus is so arranged that the steam circulates under a pressure of from two to three atmospheres, and permeates everything contained in it. Objects so sterilised are dry when removed from the steriliser. This method is specially suitable for appliances which are not damaged by steam, such, for example, as gauze swabs, towels, aprons, cotton gloves, and metal instruments.

The best substitute for circulating steam is *boiling*. The articles are placed in a "fish-kettle steriliser" and boiled for fifteen minutes in a one per cent. solution of washing-soda or of lysol.

To prevent contamination of objects which have been sterilised, they must be conveyed directly from the steriliser to the wound, on no account being touched by any one whose hands have not been disinfected and protected by sterilised gloves.

*Sterilisation by Chemical Agents.*—For the purification of the skin of the patient, the hands of the surgeon, and knives and other instruments which are damaged by heat, recourse must be had to chemical disinfecting agents. These, however, are less reliable than heat, and are open to certain other objections which will be referred to later.

In selecting from the enormous number of chemical antiseptic agents at our disposal that which is most suitable for a given case, consideration must be had to the following points :—(1) The object in view—whether to prevent septic infection or to eradicate it, and if the latter, the degree of virulence of the existing process ; (2) the irritant action, toxicity, and absorbability of the drug ; (3) the susceptibility to irritation and absorptive power of the surface to which it is to be applied ; and (4) the action of the substance upon surgical instruments.

*Carbolic Acid.*—This agent is of much historical interest, being that employed by Lord Lister when he first introduced the antiseptic system in 1867. In a field of a hundred competitors it still remains one of our most reliable antiseptics. The lotion is made by dissolving the crystals of the pure acid in water in the proportion of 1 in 20, 1 in 40, or 1 in 60. It is a reliable germicide, has a marked power of penetrating the tissues, and has no deleterious action upon metal instruments. On the other hand, it is irritating to the tissues, and induces a considerable oozing of serum from raw surfaces. If absorbed, it acts as a general poison, the first sign of its toxic effects being discoloration of the urine, which is olive-green when passed, but changes to black on standing. If absorption goes on, giddiness, nausea, and vomiting are induced. The patient may become profoundly collapsed, with a small, rapid pulse and subnormal temperature, and may ultimately die. Such accidents have occurred from absorption through unbroken skin where a compress of carbolic solution has been applied preparatory to operation, and are most to be feared in children and females with tender skin. The phenol products may be detected in the urine by adding to it a few drops of perchloride of iron solution, which gives a blue colour ; or a small quantity of bromine water, which throws down a whitish precipitate of tribromophenol.

Pure carbolic acid (phenol), when applied to a raw surface, does not produce symptoms of poisoning, as it causes coagulation necrosis of the superficial layers of the tissue, and this prevents its being absorbed.

The application of wet compresses of carbolic lotion to the fingers and toes is to be avoided, especially in women and children, on account of the risk of inducing gangrene.

*Corrosive Sublimate.*—This lotion is made by dissolving the crystals of perchloride of mercury in distilled water. It is used in strengths varying from 1 in 500 to 1 in 5000 ; that usually employed being 1 in

2000. Although less irritant locally than carbolic lotion, it is more poisonous by absorption, causing abdominal pain, diarrhœa, vomiting, and collapse, which may prove fatal. It corrodes metal instruments and dishes; and, by its action on the albumen of the tissues and of the blood, forms an inert albuminate of mercury, so that its antiseptic efficiency is much diminished. Corrosive sublimate is probably the most efficient lotion for purifying the hands after they have been contaminated with septic material. A 1 in 1000 solution of corrosive sublimate dissolved in 70 per cent. alcohol is one of the most efficient lotions for purifying the hands of the surgeon and the skin of the patient before operations.

*Lister's Strong Solution* is prepared by making a 1 in 20 solution of carbolic acid in distilled water, in every 500 parts of which one part of perchloride of mercury is dissolved.

*Biniodide of Mercury.*—This lotion is widely used as a substitute for corrosive sublimate. It is a more powerful germicide, while it is less irritant, and it neither forms a mercuric albuminate nor tarnishes metal instruments. Biniodide is used in the same strengths as corrosive sublimate, and may be dissolved either in water or in spirit.

*Iodine*, in the form of the tincture mixed with water in equal parts, is one of the most useful antiseptics to apply to infected tissues.

*Peroxide of Hydrogen* (10-15 volumes strength) is of great value in disinfecting and deodorising septic wounds and cavities. It acts in virtue of its oxidising properties. Each volume of the fluid contains from ten to fifteen volumes of oxygen in such feeble combination that it is at once given up when it comes into contact with any oxidisable substance.

*Boracic Acid Lotion* is a saturated solution of boracic acid crystals in water. It is a weak, non-poisonous lotion of some value as a preventive of sepsis, but of little germicidal power. It is useful in washing out the urinary bladder and as a mouth-wash.

*Lysol*, one of the newer proprietary antiseptics, is most useful in cleansing the skin of the patient and the surgeon's hands both before and after operations. It is used in strengths varying from 1 in 100 to 1 in 400. It combines the advantages of an antiseptic solution and a soap. Its irritating action on the skin of the hands may to a large extent be prevented by rinsing the hands in sterile water to get rid of the lysol. As it forms a ropy mixture when brought into contact with pus or blood it is not a suitable lotion for wounds.

*Formalin*, *izal*, *creolin*, *antiseptol*, and *sanitas* are useful disinfectant and deodorant lotions.

*Iodoform* is a feeble germicide, but possesses a peculiar property of neutralising the products of bacteria when it is broken up in contact with the tissues of the body. To this property—probably in virtue of the liberation of free iodine in the process of its disintegration—it owes its undoubted value in wounds with a foul discharge, in tuberculous conditions, and in venereal sores. It is also useful in wounds in the neighbourhood of septic cavities, such as the mouth or rectum, as a means of preventing or controlling sepsis. It is best employed in the form of moderate-sized crystals, which should be sterilised by immersion in 1 in 20 carbolic before being used, as micro-organisms are capable of living in the dried powder. Its odour may be disguised by mixing with it powdered Tonga bean or its active principle.

In children and in weakly old people, symptoms of poisoning by absorption may occur, in the form of loss of appetite, dry tongue, raised

temperature, and rapid pulse, and mental depression or excitement. These symptoms seem more prone to occur when the drug is used in tissues rich in fat, and especially when the fine powder is employed, this being more readily absorbed than the crystalline form. Iodoform may be detected in the urine of such patients by adding an equal quantity of concentrated hydrochloric acid, and pouring on the surface a little chloride of lime solution. At the junction of the fluids there forms a brown ring, which turns blue on the addition of starch solution.

Some persons show a peculiar idiosyncrasy with regard to their local reaction to iodoform, an acute spreading erythematous or pustular rash, with intense itching, developing from the slightest contact with it. Marked constitutional symptoms may accompany these local manifestations. In some patients persistent vomiting is induced by the smell of the drug.

*Aristol*, although inferior to iodoform, is preferred by some on account of its less offensive and less persistent odour.

**Disinfection of the Hands.**—It is now generally recognised that one of the most fertile sources of wound infection is the hands of the surgeon and his assistants. In the exigencies of surgical practice it is hardly possible for the surgeon consistently to avoid contaminating his hands with septic material, and once they are so contaminated it is extremely difficult again to render them germ-free. It is only by carefully studying to avoid all contact with infective matter that the hands can be kept surgically pure and that this source of wound infection can be reduced to a minimum. To aid in this, india-rubber gloves should be worn while operating on septic cases, such as suppurative cellulitis, osteomyelitis, suppurative appendicitis, or other conditions associated with pus formation, in making rectal or vaginal examinations, or in dressing suppurating wounds. It has been shown that if the hands be kept free of septic material for a sufficiently long period, they can for all practical purposes be rendered germ-free by ordinary methods of purification. It is of the utmost importance that any septic matter with which the hands may accidentally become defiled should not be allowed to dry on them, but should be washed off at once, and for this purpose 1 in 1000 corrosive sublimate appears to be the best lotion to employ.

The most important step in the disinfection of the hands is the mechanical removal of gross surface dirt and loose epithelium by soap, a stream of running water, and a loofah or nail-brush. Various forms of soft soap, as well as soda, turpentine, lysol, and other substances, may be used to remove grease and gross dirt from the skin. Pumice-stone soap is useful in rubbing off the loose epithelium. Of the various methods which have been suggested for purifying the hands before operating we have found the modification of Fürbringer's process suggested by Leedham-

Green the most reliable. The nails should first be cut down till there is no sulcus between the nail edge and the pulp of the finger in which organisms may lodge. The hands are then thoroughly washed for five minutes in running water as hot as can be borne, and scrubbed with a loofah or a nail-brush which has been previously sterilised by heat. They are next washed for three minutes in methylated spirit to dehydrate the skin, and then for two or three minutes in 70 per cent. sublimate-alcohol (1 in 1000). Finally, they are rubbed with dry sterilised gauze. The whole process occupies about ten minutes.

On account of the difficulty of rendering the hands surgically pure, it is advisable to wear rubber, or cotton gloves, as originally introduced by Mikulicz, while operating on all cases. It is necessary to change cotton gloves frequently during the course of a prolonged operation, because when they become moist with blood or other fluids they are permeable to the skin secretions, and organisms from the folds and ducts of the skin which have escaped the preparatory cleansing may pass through the meshes of the cotton and so reach the wound. By Kocher the gloves are used chiefly in ligaturing blood-vessels and inserting sutures, with a view to preventing the catgut or silk being contaminated by coming into contact with the surgeon's hands. In hospital practice, when a number of operations have to be performed, the surgeon and his assistants may with advantage wear sterilised cotton gloves between one operation and the next to avoid the necessity of repeatedly going through the process of purifying the hands.

**Preparation of the Skin of the Patient.**—In the purification of the skin of the patient before operation, reliance is to be placed chiefly in the mechanical removal of dirt and grease by the same means as are taken for the cleansing of the surgeon's hands. Hair-covered parts should be shaved. The skin is then dehydrated by washing with methylated spirit, followed by 70 per cent. sublimate-alcohol (1 in 1000). This is done some hours before the operation, and the part is then covered with pads of dry sterilised gauze or a sterilised towel. Immediately before the operation the skin is again purified in the same way. If any acne pustules or septic sinuses are present, they should be destroyed or purified by means of the thermo-cautery or pure carbolic acid, after the patient is anæsthetised.

*Instruments* which are not damaged by heat must be boiled in a fish-kettle or other suitable steriliser for fifteen minutes in a one per cent. solution of lysol. Just before the operation begins they are removed in the tray of the steriliser and placed

on a sterilised towel within reach of the surgeon or his assistant. If a special assistant is employed to look after the instruments, he should, after having thoroughly disinfected his hands, wear sterilised rubber gloves. Knives and instruments which are liable to be damaged by heat should be purified by being soaked in 1 in 20 carbolic for at least an hour. After operation the instruments should be boiled, dried, and kept in a dust-proof box or cupboard.

*Pads of Gauze* sterilised by compressed circulating steam have almost entirely superseded natural sponges for operative purposes. To avoid the risk of leaving swabs in the peritoneal cavity, large square pads of gauze, to one corner of which a piece of strong tape about a foot long is securely stitched, should be employed (Mikulicz). They should be removed from the caskets in which they are sterilised by means of sterilised forceps, and handed direct to the surgeon. The assistant who attends to the swabs should wear sterilised gloves.

*Ligatures and Sutures.*—To avoid the risk of implanting infective matter in a wound by means of the materials used for ligatures and sutures, great care must be taken in their preparation.

*Catgut.*—The following methods of preparing catgut have proved satisfactory:—(1) The gut is soaked in juniper oil for at least a month; the juniper oil is then removed by ether and alcohol; and the gut preserved in 1 in 1000 solution of corrosive sublimate in alcohol (Kocher). (2) The gut is placed in a brass receiver and boiled for three-quarters of an hour in a solution consisting of 85 per cent. absolute alcohol, 10 per cent. water, and 5 per cent. carbolic acid, and is then stored in 90 per cent. alcohol. (3) Cladius recommends that the catgut, just as it is bought from the dealers, be loosely rolled on a spool, and then immersed in a solution of—iodine, 1 part; iodide of potassium, 1 part; distilled water, 100 parts. At the end of eight days it is ready for use. Moschcowitz has found that the tensile strength of catgut so prepared is increased if it is kept dry in a sterile vessel, instead of being left indefinitely in the iodine solution. To avoid contamination from the hands catgut should be removed from the bottle with aseptic forceps and passed direct to the surgeon. Any portion unused should be thrown away.

*Silk.*—If rendered sterile, the smaller sizes of silk, Nos. 1 and 2, may be used for the ligature of blood-vessels. It is prepared by being soaked for twelve hours in ether, for other twelve in alcohol, and then boiled for ten minutes in 1 in

1000 sublimate solution. It is then wound on to spools with purified hands protected by sterilised gloves, and kept in absolute alcohol. Before an operation the silk is again boiled for ten minutes in the same solution, and is used directly from this (Kocher). Linen or celluloid thread is sterilised in the same way as silk.

Horse-hair, fishing-gut, and silver wire, as well as the needles, should be boiled along with the instruments.

The field of operation is surrounded by macintoshes covered over with sterilised towels, securely fixed in position so that no contamination may take place from the surroundings.

The surgeon and his assistants, including the anæsthetist, should wear overalls sterilised by steam. To avoid the risk of infection from dust, scurf, or drops of perspiration falling from the head the surgeon and his assistants should wear sterilised cotton caps. It has been shown that there is considerable risk of infection taking place by drops of saliva projected from the mouth in talking or coughing in the vicinity of a wound. To obviate this risk a simple mask should be worn.

The risk of infection from the *air* is now known to be very small, so long as there is no excess of dust floating in it. All sweeping, dusting, and disturbing of curtains, blinds, or furniture must therefore be avoided before or during an operation.

It has been shown experimentally that the presence of spectators increases the number of organisms in the atmosphere. In teaching clinics, therefore, the risk from air infection is greater than in private practice.

To facilitate primary union, all hæmorrhage should be carefully arrested, and the accumulation of fluids in the wound prevented. When much oozing of serum or blood is anticipated, a glass or rubber drainage-tube should be inserted through a small opening specially made for the purpose. In aseptic wounds the tube may be removed in from twenty-four to forty-eight hours; in infected wounds it must remain as long as the discharge lasts.

The edges of the wound should be brought into accurate apposition by sutures. If any cavity exists in the deeper part of the wound, it should be obliterated by buried sutures, or by so adjusting the dressing as to bring its walls into apposition.

If our precautions have been successful, the wound will heal under the original dressing, which need not be interfered with for from ten to fourteen days according to the nature of the case.

**Dressings.**—*Gauze*, either sterilised by heat, or impregnated

with corrosive sublimate, double cyanide of mercury and zinc, iodoform, or other antiseptic agent, is now widely used in the treatment of wounds.

Pads of *sterilised gauze* are extensively used as a dressing for operation wounds. *Double cyanide gauze* is to be preferred in such regions as the neck, axilla, or groin, where complete sterilisation of the skin is difficult to attain, and where it is desirable to leave the dressing undisturbed for ten days or more. *Iodoform gauze* is of special value for the packing of wounds treated by the open method.

One variety or another of *wool*, rendered absorbent by the extraction of its fat, and sterilised by heat, forms a part of almost every surgical dressing, and various antiseptic agents may be added to it. Of these corrosive sublimate is the most generally used. Wood-wool dressings are more highly and more uniformly absorbent than cotton wools. As evaporation takes place through wool dressings, the discharge becomes dried, and so forms an unfavourable medium for bacterial growth.

*Boracic Lint* is prepared by soaking ordinary lint in a hot concentrated solution of boracic acid and then drying it. It is usually employed as a wet dressing or poultice, being wrung out of boracic lotion, applied to the part, and covered with gutta-percha tissue.

**Means adopted to combat Septic Infection.** — As has already been indicated, the same antiseptic precautions are to be taken in dealing with infected as with aseptic wounds.

In the case of *recent injuries* such as result from railway or machinery accidents, with bruising and crushing of the tissues, and grinding of gross dirt into the wounds, the scissors must be freely used to remove the tissues which have been devitalised, or impregnated with foreign material. Hair-covered parts should be shaved. Crushed and contaminated portions of bone should be chiselled away. Opinions differ as to the benefit derived from washing such wounds with strong lotions, which are liable to devitalise the tissues with which they come in contact, and so render them less able to resist the action of any organisms which may remain in them. All are agreed, however, that free washing with normal salt solution is useful in mechanically cleansing the injured parts. Peroxide of hydrogen sprayed over such wounds is also beneficial in virtue of its oxidising properties. Efficient drainage must be provided, and stitches should be used sparingly, if at all.

The best way in which to treat such wounds is by the

*open method.* This consists in packing the wound with iodoform gauze, which is left in position as long as it adheres to the raw surface. The packing may be renewed at intervals until the wound is filled by granulations; or in the course of a few days, when it becomes evident that the septic infection has been overcome, *secondary* sutures may be introduced and the edges drawn together, provision being made at the ends for further packing or for drainage-tubes. These measures have been found specially useful in military surgery.

If earth or street dirt has entered the wound, before introducing the iodoform gauze, the surface may with advantage be brushed over with pure carbolic acid, as virulent organisms, such as those of tetanus or spreading gangrene, are liable to be present.

When septic processes have become established in a wound, and suppuration is going on and probably spreading in the tissues, the first essential in treatment is to ensure free drainage by openings and counter-openings, if necessary. The open method is the only safe means of treating such wounds. The infected surface may be sponged over with pure carbolic acid, the excess of which is washed off with absolute alcohol, and the wound either drained by tubes or packed with iodoform gauze. The practice of scraping such surfaces with the sharp spoon, squeezing, or even of washing them out with antiseptic lotions, is attended with the risk of further diffusing the organisms in the tissue, and is only to be employed under exceptional circumstances. Continuous irrigation of septic wounds or their immersion in antiseptic baths is sometimes useful.

Wounds in the vicinity of the mouth or rectum are treated on the same principles as infected wounds—by the open method.

# CHAPTER IV.

## INFLAMMATION.

Nature of inflammation from surgical point of view — Sequence of changes in inflammation — Clinical aspects of inflammation — General principles of treatment—Results of inflammation—Chronic inflammation.

The infection of a wound by pathogenic bacteria is soon followed by a complex series of changes in the affected tissues which constitutes the process of inflammation. This process is to be looked upon as the reaction of the tissue elements to the irritation caused by the invading micro-organisms and their products. Certain tissue changes similar to, if not identical with, those of inflammation due to bacterial action result from mechanical or thermal injury of a part, or the application of purely chemical substances to the tissues; and the early stages in the process of ideal repair are characterised by changes of a like kind. From the clinical point of view, however, these processes are to be looked upon as the physiological effects of *stimulation* of the tissues acting reflexly through the nervous system, rather than as the pathological results of *irritation*. The local structural changes and the general constitutional effects of these conditions differ so widely from those of true inflammation of bacterial origin, that to attempt to include all in one category seems calculated to obscure the essential characters of each and to lead to confusion. The true significance of inflammation in surgical pathology will only be appreciated when bacterial action is accepted as its only cause.

Inflammatory reaction appears to have for its primary object the arrest and expulsion of the attacking organisms, and to this extent may be looked upon as protective in its nature. Should the issue of the struggle between the tissues and the bacteria be favourable to the latter, the further phases of the inflammatory process are essentially of a destructive character. The idea

that inflammation is a reparative process, as is held by some, cannot be entertained. Clinical experience and pathological facts prove the existence of inflammation in a wound to be incompatible with repair. Any healing which may take place in an inflamed wound goes on in spite of the inflammation and not as a result of it, and in most cases repair only begins when inflammation ceases. It has already been pointed out that the fundamental object of our modern methods of wound treatment is the prevention of inflammation, and that it is only when we succeed in attaining this object that we obtain that form of repair which we consider ideal. To admit that inflammation is essential to repair is to relinquish the antiseptic idea.

**Sequence of Changes in Inflammation.**—For purposes of study the process of inflammation may be divided into four phases or stages—hyperæmia, congestion, stasis, and thrombosis; but as these stages imperceptibly merge into one another, and as the inflammatory process may become arrested at any stage, it is to be understood that the subdivision is to a large extent arbitrary. The characteristic tissue changes take place in and around the minute blood-vessels of the inflamed part. In the *normal capillary* the red corpuscles flow in the centre of the stream, while the leucocytes move along more slowly towards the periphery of the vessel.

The first or *hyperæmic* stage of inflammation supervenes on the infection of a wound, and is characterised by an increased rapidity in the blood-flow, a dilatation of the capillaries implicated, and an increased exudation of serous fluid into the surrounding connective tissue. The amount of blood passing through the inflamed area is greatly increased, and on account of this increased quantity of blood, the short time it remains in the part, and the diminished metabolic activity of the tissues, it does not lose its oxygen, and so remains of a bright red colour. The clinical features of this stage, therefore, are redness and œdematous swelling. As the serous exudation from the dilated vessels does not coagulate, the part remains soft and pits on pressure.

In the stage of *congestion* the vessels still further dilate, but the rate of flow diminishes, and the white corpuscles accumulate against the capillary wall. In this stage the part becomes more swollen and of a darker hue.

As the vitality of the tissue continues to diminish, the activity of the bacteria increases so that a greater quantity of toxins is produced, and further evidence of their action on the tissues becomes manifest. The accumulation of leucocytes in the

peripheral parts of the vessels increases, the blood as it comes into contact with the devitalised portions of the vessel wall has its flow arrested,—*stasis*,—and the red corpuscles fall out of the central part of the vessel and mix with the serum and leucocytes. Leucocytes find their way through the walls of the small veins and capillaries in gradually increasing numbers, till the whole of the connective tissue in the vicinity becomes infiltrated with them—*emigration of leucocytes*. The fluid portion of the blood also exudes through the walls, and the connective tissue becomes water-logged. Red corpuscles are carried out through the openings made by the leucocytes, and lie singly or in clumps in the meshes of the connective tissue—*diapedesis of red corpuscles*.

The emigration of leucocytes, resulting in a local leucocytosis, is one of the most important phenomena of inflammation, and on it the protective character of the inflammatory process depends. The determination of leucocytes to the seat of bacterial invasion enables them to bring their phagocytic action to bear against the organisms, and so to check their advance. Coincidently with these changes, a proliferation of the fixed tissue cells of the part takes place.

As has been said, the serous exudate in this stage of inflammation is copious, and it varies in character with different micro-organisms and in different tissues.

When the exudate remains fluid, it is spoken of as *serous*, as in serous synovitis. In most inflammations the exuded fluid coagulates more or less completely, and is then termed *sero-fibrinous*. On the free surface of mucous membranes it sometimes forms a dull grey tough layer, composed of a mixture of fibrin, mucin, and dead epithelial cells, constituting a *croupous* exudate. In very vascular tissues with friable vessels, during an acute inflammation, somewhat copious bleeding may accompany the exudation into the tissues—*hæmorrhagic* exudate. Other terms, which explain themselves, are applied to inflammatory exudates, such as purulent, putrid, ichorous.

In severe and long-continued inflammation the endothelium of the vessels becomes so profoundly altered that *thrombosis*, or clotting of the blood in the vessels, takes place. In the thrombotic stage of inflammation the blood-flow is completely and permanently arrested, and the vitality of the tissue is seriously endangered.

**Clinical Aspects of Inflammation.**—It must clearly be understood that inflammation is not to be looked upon as a disease in itself, but rather as an evidence of some infective process going on in the tissues in which it occurs, and of an

effort on the part of these tissues to overcome the invading organisms and their products. The chief danger to the patient lies, not in the reactive changes which constitute the inflammatory process, but in the fact that he is liable to be poisoned by the toxins of the bacteria at work in the inflamed area.

Since the days of Celsus (first century, A.D.), heat, redness, swelling, and pain have been recognised as cardinal signs of inflammation, and to these may be added, interference with function in the inflamed part, and general constitutional disturbance. Variations in the intensity of these signs and symptoms depend upon the acuteness of the condition, the nature of the causal organism and of the tissue attacked, the situation of the part in relation to the surface, and other factors.

The *heat* of the inflamed part is to be attributed to the increased quantity of blood present in it, the actual temperature of the blood at the seat of inflammation being no higher than in other parts of the body. The more superficial the inflamed part the more readily is the local increase of temperature detected by the hand. This clinical point is best tested by placing the palm of the hand and fingers for a few seconds alternately over an uninflamed and an inflamed area, otherwise under similar conditions as to coverings and exposure. In this way even slight differences may be recognised.

*Redness*, similarly, is due to the increased afflux of blood to the inflamed part. The shade of colour varies with the stage of the inflammation, being lighter and brighter in the early, hyperæmic stages, and darker and duskier when congestion and stasis have occurred and the oxygenation of the blood is defective. In the thrombotic stage the part may assume a purplish hue.

When a deep part, such as periosteum or bone, is the seat of inflammation, surface redness may be absent.

The *swelling* is due to the increased quantity of material in the affected part—circulating blood, effused serum and leucocytes, and proliferated tissue cells. The more open the structure of the tissue of the part, the greater is the amount of swelling, witness the marked degree of swelling which occurs in such parts as the scrotum or the eyelids. In deep-seated inflammations of rigid tissues or encapsuled organs, however, there is often a marked œdematous swelling of the overlying soft parts, due to direct or reflex interference with the circulation of the part.

*Pain* is a symptom seldom absent in inflammation. *Tenderness*—that is, pain elicited on pressure—is one of the most valuable diagnostic signs we possess, and is often present before

pain is experienced by the patient. That the area of tenderness corresponds to the area of inflammation, is almost an axiom of surgery. Pain and tenderness are due to the local irritation of nerve filaments, rendered all the more sensitive by the abnormal conditions of their blood-supply.

Much value attaches to the character of the pain as described by the patient. Thus inflammations of the skin cause pain of a *burning* or *itching* character; the pain of inflammation in dense tissues like periosteum or bone, or in encapsuled organs, is described as *dull*, *boring*, or *aching*. When inflammation is passing on to suppuration the pain assumes a *throbbing* character, and as the pus reaches the surface, or "points," as it is called, sharp, *darting*, or *lancinating* pains are experienced. Inflammation involving a nerve-trunk may cause a *boring* or a *tingling* pain; while the implication of a serous membrane such as the pleura or peritoneum gives rise to pain of a sharp *stabbing* character.

Pain may be *referred* to parts at a distance from the actual seat of the inflammation; for example, pain in the knee is a common symptom of disease in the hip-joint.

*Interference with the function* of the inflamed part is always present, varying in degree with the severity of the inflammation and its seat. An inflamed joint, for example, may have its range of movement diminished or may be absolutely fixed; an inflamed eye may be hypersensitive to light or may be rendered blind.

**Constitutional Disturbances.**—Under the term constitutional disturbances are included the presence of fever or elevation of temperature; certain changes in the pulse rate and the respiration; gastro-intestinal and urinary disturbances; and derangements of the central nervous system. These are all due to the absorption of toxins into the general circulation.

*Fever.*—The nature and significance of alterations in the temperature in inflammatory and other pathological conditions have already been referred to (p. 23).

The *pulse* is always increased in frequency during inflammation and usually varies directly with the height of the temperature. In the early stages, while the temperature is rising, it may be small and firm; during the height of the inflammation it is full and bounding; and if the process be long continued it tends to become small, soft, and weak, or even dicrotic and irregular.

*Respiration* is more active during the progress of an inflammation. Bronchial catarrh is common, apart from any antecedent local respiratory disease.

*Gastro-intestinal disturbances* are usually present in the

form of loss of appetite, diminished secretion of the alimentary juices, and weakening of the peristalsis of the bowel, leading to thirst, dry, furred tongue, and constipation. Diarrhœa is sometimes present.

The *urine* is usually scanty, of high specific gravity, rich in nitrogenous substances, especially urea and uric acid, and in calcium salts, while sodium chloride is deficient. Albumen and hyaline casts may be present in cases of severe inflammation with high temperature.

*Leucocytosis* generally accompanies acute inflammation.

**Clinical Features of Inflammation complicating a Surgical Wound.**—If in the course of a surgical operation bacterial infection of the wound has occurred, inflammatory reaction soon manifests itself. In from twenty-four to forty-eight hours after the operation the patient is conscious of a sensation of chilliness, or may even have a distinct rigor. At the same time he feels generally out of sorts, with impaired appetite, headache, and it may be looseness of the bowels. His temperature rises to 100° or 101° F., and the pulse quickens to 100 or 110.

On exposing the wound it is found that the parts for some distance around are red, glazed, and œdematous. The discoloration and swelling are most intense in the immediate vicinity of the wound, the edges of which are everted and moist. Any stitches which may have been introduced are tight, and the deep ones may be cutting into the tissues. There is heat, and a constant burning or throbbing pain, which is increased by pressure. On inserting a probe between the lips of the wound a quantity of dark serous or sanious fluid escapes, or the discharge may even already have become purulent.

**General Principles of Treatment in Inflammatory Conditions and in Inflamed Wounds.**—The main object of treatment in these conditions is to help the tissues in the contest with the bacteria and their toxins. This is done in two ways —(1) by attacking the organisms and so removing the cause of the inflammation; and (2) by improving the condition of the tissues so as to increase their power of defending themselves.

The bacteria may be attacked directly by means of strong antiseptic agents locally applied.

In such conditions, for example, as acute lymphangitis, or diffuse inflammation of the subcutaneous tissue, where the skin is unbroken, carbolic acid, in virtue of its penetrating power, if applied on fomentations in the strength of 1 to 40, will act directly on the organisms, and so allay the inflammation.

On open surfaces, and in acne spots, boils, or similar conditions, the undiluted acid may be locally applied with the same object.

By establishing free drainage, so that no fluid discharges are allowed to remain in the tissues, and by keeping the surface dry, the organisms may be starved out.

Various drugs administered internally, such as quinine, salol, salicylate of iron, and others, have a reputation, more or less deserved, as internal antiseptics.

The toxins may be neutralised locally by such applications as iodoform or its substitutes; or their elimination may be hastened by stimulating the emunctories. A saline purge, such as half an ounce of sulphate of magnesium in a small quantity of water, ensures a free evacuation of the bowels. The kidneys are flushed by such diluent drinks as equal parts of milk and lime-water, or milk with a dram of liquor calcis saccharatus added to each tumblerful. Barley-water, and "Imperial drink," which consists of a dram and a half of cream of tartar added to a pint of boiling water and sweetened with sugar after cooling, are also useful and non-irritating diuretics.

The skin may be stimulated by Dover's powder (10 grains), or liquor ammoniæ acetatis in three-dram doses every four hours.

The general health of the patient must be kept up by regularly administered diets of fluid food, such as milk, beef-tea, meat juices or gruel, rendered more easily assimilable by artificial digestion if necessary. Stimulants and tonics will be given if indicated.

The tissues of the inflamed part are aided in their struggle with the bacteria by receiving a plentiful supply of healthy blood, and it has hitherto been the practice deliberately to facilitate the venous return from an inflamed area in order that fresh arterial blood might reach it. Recent observations by Bier of Bonn, however, seem to indicate that a certain degree of venous congestion artificially induced in the inflamed area is beneficial (p. 62).

*Blood-letting.*—In some cases more active aid must be given to the circulation by the relief of congestion by blood-letting, which may be general or local. *General blood-letting* consists in opening a superficial vein (venesection) and allowing from eight to ten ounces of blood to flow from it.

*Local blood-letting* is a commoner surgical practice than venesection, and may be effected by leeches, cupping, or incision.

Before applying *leeches* the part must be thoroughly cleansed, and if the leech is slow to bite, may be smeared with cream. The leech is retained in position under an inverted wine-glass or wide test-tube till it takes hold. After it has sucked its fill it usually drops off, having withdrawn about a dram or a dram and a half of blood. If it be desirable to withdraw more blood, hot fomentations should be immediately applied to the bite. As it is sometimes necessary to employ considerable pressure to stop bleeding from a leech bite, leeches should, if possible, be applied over a bone which will furnish the necessary resistance. The use of styptics may be called for.

*Cupping.*—Two methods of cupping are employed—dry and wet. In *dry cupping*, a small tumbler, the inside edge of which has previously been oiled, has a piece of blotting-paper soaked in methylated spirit placed in it and ignited, and while this is still burning the tumbler is inverted and pressed firmly over the part to be cupped. The burning of the air and the subsequent cooling create a partial vacuum inside the glass, and the skin and subcutaneous tissue full of blood and fluid are drawn into it. To release the glass the finger-nail is gently inserted under its edge.

In *wet cupping*, the skin is scarified by a lancet before the cup is applied. Each cup withdraws about two or three drams of blood, and if more is desired, hot fomentations may be applied.

*Free incisions*, with antiseptic precautions, are safe and certain as a means of letting blood, and may be called for in deep-seated inflammations to relieve extreme tension.

*Counter-irritants.*—In deep-seated inflammations counter-irritants are sometimes employed in the form of mustard leaves or blisters, according to the degree of irritation required. A mustard leaf or plaster should not be left on longer than ten or fifteen minutes, unless it is desired to produce a blister. Blistering may be produced by a *cantharidis plaster*, or by painting with *liquor epispasticus*. The plaster should be left on for from eight to ten hours, and if it has failed to raise a blister, a hot fomentation should be applied to the part. Liquor epispasticus, alone or mixed with equal parts of collodion, is painted on the part with a brush. Several paintings are often required before a blister is raised. The removal of the natural grease from the skin by ether favours the action of these applications.

*Cold.*—Cold is only to be employed in the early hyperæmic stages of inflammation. It acts by contracting the blood-vessels and so diminishing the amount of blood reaching the part. In

the stages of congestion or stasis its use is attended with considerable risk, as it diminishes the blood-flow from the part and may determine gangrene of tissues already devitalised.

*Dry cold* may be employed by means of ice-bags, or by Leiter's lead tubes through which a continuous stream of ice-cold water is kept flowing.

A milder form of employing cold is by means of *evaporating lotions.* A thin piece of lint or gauze is applied over the inflamed part and is kept constantly moist with the lotion, the dressing being left freely exposed to allow of continuous evaporation. A useful evaporating lotion is made up as follows:— Take of chloride of ammonium, half an ounce; rectified spirit, one ounce; and water, seven ounces.

*Heat* is indicated in the later stages of inflammation, especially when deep-seated parts are affected. It is best employed by means of a *fomentation.* A piece of flannel or lint is wrung out of very hot water or antiseptic lotion (1 in 40 or 1 in 60 carbolic) and applied under a sheet of macintosh. Fomentations should be renewed as often as they cool. An ordinary india-rubber bag, filled with hot water and fixed over the fomentation, by retaining the heat, obviates the necessity of frequently changing the application. The addition of a few drops of laudanum sprinkled on the flannel has a soothing effect.

Lead and opium lotion is a useful, soothing application employed as a fomentation.

*General Treatment.*—In addition to the means taken to combat inflammation, treatment includes the alleviation of certain of its results. Pain, for instance, may be relieved by warm and moist local applications, such as lead and opium fomentations; belladonna and glycerin, equal parts; ichthyol ointment (1 in 3), or a 10 per cent. aqueous solution of ichthyol. The internal administration of opiates may be necessary.

In surgical inflammations, as a rule, nothing is gained by lowering the temperature, unless at the same time the cause is removed. When severe or prolonged pyrexia becomes a source of danger, the use of hot or cold sponging, or even the cold bath, is preferable to the administration of drugs internally.

Weakness of the heart, as indicated by the condition of the pulse, is treated by the use of alcohol, digitalis, strophanthus, or strychnine, according to circumstances.

Gastro-intestinal disturbances are met by ordinary medical means; and derangements of the nervous system by the use of chloral, bromides, or other nerve sedatives.

The treatment of inflammation in special tissues and organs will be considered in the sections devoted to regional surgery.

**Terminations of Inflammation.**—When death results it is usually due to the absorption of excessive doses of bacterial toxins, as in sapræmia and septicæmia. In some cases the inflamed organ, such as the brain, the lungs, or the kidneys, is so essential to life that the continued interference with its function proves fatal.

On the other hand, inflammation may pass off and complete recovery ensue, in which case *resolution* is said to take place. The removal of the cause is followed by the return of the local circulation to the normal, and the ultimate reabsorption of inflammatory products.

In certain situations, notably in tendon sheaths, the cavities of joints, and the interior of serous cavities—for example, the pleura and peritoneum—the restoration to the normal condition is incomplete, fibrous adhesions forming between the adjacent surfaces of the inflamed structures.

**Chronic Inflammation.**—Chronic inflammatory processes are almost invariably due to the action of the specific virus of such affections as tubercle, syphilis, actinomycosis, or other infective disease, and will be described in the sections dealing with these conditions.

# CHAPTER V.

## SUPPURATION.

Definition—Pus—*Varieties*—Acute circumscribed abscess—*Acute suppuration in a wound*—*Acute suppuration in a mucous membrane*—Diffuse cellulitis and diffuse suppuration—*Clinical features of diffuse suppuration in different situations*—*Whitlow*—Chronic suppuration—Sinus, Fistula—Fevers due to the action of pyogenic bacteria—*Saprœmia*—*Septicœmia*—*Pyœmia.*

Suppuration, or the formation of pus, is one of the results of the action of certain bacteria on the tissues of the body. The invading organism is usually one of the staphylococci, less frequently a streptococcus, and still less frequently one of the other bacteria capable of producing pus, such as the bacillus coli communis, the gonococcus, the pneumococcus, or the typhoid bacillus.

So long as the tissues are in a healthy condition they are able to withstand the attacks of moderate numbers of pyogenic bacteria of ordinary virulence, but when devitalised by disease, by injury, or by inflammation due to the action of other pathogenic organisms, suppuration ensues.

**Pus.**—The fluid resulting from the process of suppuration is known as *pus*. In its typical form it is a yellowish creamy substance, of alkaline reaction, with a specific gravity of about 1030, and it has a peculiar mawkish odour. If allowed to stand in a test-tube it does not coagulate, but separates into two layers: the upper, transparent, straw-coloured fluid, the *liquor puris* or pus serum, closely resembling blood serum in its composition, but containing less proteid and more cholesterin; it also contains leucin, tyrosin, and certain albumoses which prevent coagulation.

The solid constituents form a layer at the bottom of the tube, consisting largely of dead leucocytes and fixed tissue cells (*pus corpuscles*). Red corpuscles, micro-organisms, fibrin,

fat, mucin, cholesterin crystals, and small portions of necrosed tissue are also present.

As seen with the microscope, pus cells have a well-defined rounded outline, are colourless, and contain granular protoplasm and a multi-partite nucleus. They show amœboid movement.

*Variations from Typical Pus.* — Pus from old-standing sinuses is often watery in consistence (ichorous), with a low specific gravity (1020) and few cells. Where the granulations are vascular and bleed easily it becomes sanious from admixture with red corpuscles; while if a blood-clot be broken down and the debris mixed with the pus, it contains granules of blood pigment and is said to be grumous. The *odour* of pus varies with the different bacteria producing it. Pus due to ordinary pyogenic cocci has a mawkish odour; when putrefactive organisms are present it has an extremely offensive putrid odour; when it forms in the vicinity of the intestinal canal it usually contains the bacillus coli communis, and has a fæcal odour.

The *colour* of pus also varies: when due to one or other of the varieties of the bacillus pyocyaneus it is usually of a blue or green colour; when mixed with bile derivatives or altered blood pigment it may be of a bright orange colour. In wounds inflicted with rough iron implements from which rust is deposited the pus often presents this same colour.

The pus may form and collect within a circumscribed area, constituting a localised *abscess*; or it may infiltrate the tissues over a wide area—*diffuse suppuration.*

## Acute Circumscribed Abscess.

Any tissue of the body may be the seat of an acute abscess, and there are many routes by which the bacteria may gain access to the affected area. For example: an abscess in the integument or subcutaneous cellular tissue usually results from infection by organisms which have entered through a wound or abrasion of the surface or along the ducts of the skin; an abscess in the breast from organisms which have passed along the milk ducts opening on the nipple or along the lymphatics which accompany these. An abscess in lymphatic glands is usually due to infection passing by way of the lymphatic channels from the area of skin or mucous membrane drained by them. Abscesses in internal organs, such as the kidney, liver, or brain, usually result from infection by organisms carried in the blood-stream from some

focus of suppuration elsewhere in the body, or from a lesion of the skin or mucous membrane.

**Formation of an Abscess.** — When virulent pyogenic bacteria settle in a part there ensues an inflammatory reaction, producing congestion and stasis in the blood-vessels, migration of leucocytes, and exudation of plasma into the surrounding tissues. The toxins formed by the bacteria induce degenerative changes in the endothelial cells of the vessel walls, in the connective-tissue corpuscles, and in the wandering leucocytes. Towards the centre of the inflamed area, where this action is most concentrated, coagulation necrosis takes place, and in the dead material thus produced the bacteria grow and multiply. By means of a digestive ferment secreted by the organisms, and probably also by phagocytic action, the necrosed tissue becomes liquefied, and a focus of pus is formed, constituting an *abscess*. Around this is a zone of coagulated or necrotic tissue ready to break down as the process extends; and this in turn is surrounded by a ring of leucocyte infiltration which acts as an obstacle to the further spread of the bacteria.

The pus thus formed is, owing to the swelling and condensation of the parts around, under considerable pressure, which causes it to spread along the lines of least resistance. In the case of a subcutaneous abscess the pus usually spreads directly to the surface, and "points," as it is called. Where the abscess points, the skin becomes soft and thin, and sloughs form at one or more spots, giving exit to the pus.

An abscess forming in the deeper planes is prevented from pointing directly to the surface by the firm fasciæ and other fibrous structures. The pus therefore tends to burrow along the line of the blood-vessels and in the connective-tissue septa, till it either finds a weak spot or causes a portion of fascia to slough and so reaches the surface. Accordingly many abscess cavities resulting from deep-seated suppuration are of irregular shape, with pouches and loculi in various directions—an arrangement which interferes with their successful treatment by incision and drainage.

The relief of tension which follows the bursting of an abscess, the removal of irritation by the escape of pus, and the throwing out of bacteria and toxins, allow the tissues once more to assert themselves. Granulation tissue forms round the abscess cavity, gradually increases in amount, and becomes organised into connective tissue, which eventually fills the gap resulting from the destruction of the original tissues; epithelium covers the granulating surface and the scar is thus completed. As a result

of the subsequent contraction of the newly formed connective tissue, the scar is usually depressed below the level of the surrounding skin surface.

If an abscess is prevented from healing—for example, by the presence of a foreign body or a piece of necrosed bone—a sinus results, and from it pus escapes until the foreign body is removed.

**Clinical Features of an Acute Circumscribed Abscess.**—The formation of an acute abscess is always preceded and accompanied by the presence of inflammation, and the clinical characters of the two conditions are blended. Rigors, increased elevation of temperature, progressive leucocytosis, and sweating, mark the transition between inflammation and suppuration. In some cases an increasing leucocytosis is the only available evidence that a suppurative process is spreading. On the other hand, if the toxæmia is intense the leucocytes may diminish in number and even fall below the normal.

The local symptoms vary with the seat of the abscess. When it is situated superficially—for example, in the breast tissue—the affected area is hot, the redness of inflammation gives place to a dusky purple colour, with a pale, sometimes yellow, spot where the pus nears the surface. The swelling increases in size, the firm brawny centre becomes soft, projects as a cone beyond the level of the rest of the swollen area, and is usually surrounded by a zone of induration.

By placing the fingers of one hand over a part of the swelling, and gently tapping or pressing at another part, a fluid wave may be detected in the softened area. This is known as *fluctuation*, and when present is a certain indication of the existence of fluid in the swelling. Its recognition, however, is by no means easy, and various fallacies are to be guarded against in applying this test clinically. When, for example, the walls of the abscess are thick and rigid, or when its contents are under excessive tension, the fluid wave cannot be elicited. On the other hand, a sensation closely resembling true fluctuation may often be recognised on palpating œdematous tissues, certain soft solid tumours such as fatty tumours or vascular sarcomata, and in some cases of aneurysm. When palpated in its transverse axis, a large muscular mass, such as the gluteal muscles, also yields this pseudo-fluctuation.

When pus has formed in deeper parts, and before it has reached the surface, œdema of the overlying skin is very frequently present, and the skin pits on pressure.

With the formation of pus the continuous burning or boring pain of inflammation assumes a throbbing character, with

occasional sharp, lancinating twinges. Should doubt remain as to the presence of pus, recourse may be had to the use of an exploring needle.

*Differential Diagnosis of Acute Abscess.*—A practical difficulty which frequently arises is to decide whether or not pus has actually formed. It may be accepted as a working rule in practice that when an acute inflammation has lasted for four or five days without showing signs of abatement, suppuration has almost certainly occurred. In deep-seated suppuration, marked œdema of the skin and the occurrence of rigors and sweating may be taken to indicate the formation of pus. When any doubt remains it is best to assume the presence of pus and to act accordingly.

There are cases on record where rapidly-growing sarcomatous and angiomatous tumours, aneurysms, and the bruises which occur in hæmophylics, have been mistaken for acute abscesses and incised.

**Treatment of Acute Abscess.**—The dictum of John Bell, "Where there is pus, let it out," must be rigidly and promptly acted upon. The extent and situation of the incision will be regulated by the size of the abscess and its anatomical relations, but in all cases it should be sufficiently free to ensure thorough emptying of the cavity and to admit of efficient drainage. Large abscesses should be drained by glass or rubber tubes; smaller abscesses by strands of iodoform worsted or of rubber tissue.

In some cases the cavity should be laid freely open in its whole extent, stuffed with iodoform gauze, and treated by the open method. It is seldom advisable to wash out an abscess cavity. Squeezing out the pus is also to be avoided, lest the protective zone be broken down and the infection be diffused into the surrounding tissues.

The importance of adopting antiseptic precautions in opening an abscess can scarcely be exaggerated, and the rapidity with which healing occurs when the access of fresh bacteria is prevented is in marked contrast to what occurs when antiseptic precautions are neglected and further infection is allowed to take place. The wound should be dressed the next day, and the tube shortened, in the case of a rubber tube, by cutting off a portion of its outer end. On the second day or later, according to circumstances, the tube is removed, and after this the dressing need not be repeated oftener than every second or third day.

Where pus has formed in relation to important structures—as, for example, in the deeper planes of the neck—*Hilton's method* of opening the abscess may be employed. An incision is made

through the skin and fascia, a grooved director is gently pushed through the deeper tissues till pus escapes along its groove, and then the track is widened by passing in a pair of dressing forceps and expanding the blades. A tube is introduced, and the subsequent treatment carried out as in other abscesses. When the tube lies in proximity to a large blood-vessel, it should be split open, and care must be taken not to leave it in position long enough to cause ulceration of the vessel wall by pressure.

Acute suppuration in lymphatic glands, bones, joints, serous cavities, and internal organs will be described later.

*Acute Suppuration in a Wound.*—When a wound is infected by pyogenic bacteria, the pathological changes already described as occurring in the formation of a circumscribed abscess take place, modified by the fact that the pus can reach the surface by bursting through the line of incision. The parts around become red, swollen, œdematous, and painful; the stitches are tightened by the swelling, and cut into the tissues. At last the feebly united edges of the wound separate, and the pus escapes. If the stitches be now cut, pus escapes more freely, the wound gapes, and its surfaces are found to be covered with granulations bathed in pus. The surrounding inflammation subsides, the discharge of pus lessens, and healing takes place by the formation of granulation tissue—the so-called "healing by second intention."

While the pus is forming the temperature rises, and a rigor may occur. The free opening up of the wound is almost immediately followed by a fall in the temperature.

Wound infection may take place from *catgut* which has not been successfully sterilised. The local and general reactions in these cases may be very slight, and, as a rule, do not appear for seven or eight days after the operation, and, it may be, not till after the wound has healed on the surface. The pus is thick and dark, and is strictly localised to the part of the wound where catgut was employed for stitches or ligatures. It usually shows little tendency to spread throughout the whole wound, but the infected part is often long of healing.

When suppuration occurs in connection with buried sutures of unabsorbable materials, such as silk, silkworm gut, or silver wire, it is apt to persist till the foreign material is cast off or removed.

Suppuration may occur along the line of skin stitches, producing *stitch abscesses*. The infection may arise from the material used, especially catgut or silk, or, more frequently perhaps, from the growth in the patient's skin of staphylococcus albus when the part has been imperfectly disinfected.

*Acute Suppuration of a Mucous Membrane.*—When pyogenic organisms gain access to a mucous membrane, such as that of the bladder, urethra, or middle ear, the usual phenomena of acute inflammation and suppuration ensue, followed by the discharge of pus from the free surface. It would appear that the most marked changes take place in the sub-mucous tissue, causing the covering epithelium in places to die and leave small superficial ulcers. When mucous glands are present in the membrane the pus is mixed with mucus—*muco-pus.*

### Diffuse Cellulitis and Diffuse Suppuration.

Cellulitis is an acute inflammatory affection resulting from the introduction of some organism—commonly the *streptococcus pyogenes*—into the cellular connective tissue of the integument, intermuscular septa, tendon sheaths, or other structures. The process always begins in a wound, although this may be small, superficial, and insignificant, such as a pin-prick, a scratch, or a crack under a nail, and the wound may have been healed for some time before the inflammation sets in. The cellulitis, also, may develop at some distance from the seat of inoculation, the organisms having travelled by the lymphatics. While it is true that the inflammation may resolve without the formation of pus, such a result is exceptional, and it is convenient to consider the preliminary inflammation—the cellulitis—and the resulting suppuration together.

The virulence of the organisms, the loose, open nature of the tissues in which they develop, and the free lymphatic circulation by means of which they are spread, tend to make the resulting inflammatory and suppurative processes become diffuse. Sometimes numbers of cocci are carried for a considerable distance from the primary area before they are arrested in the lymphatics, and thus several patches of inflammation may appear with healthy areas between.

As a result of the virulence of the bacteria and their toxins, in many cases there is sloughing of considerable portions of tissues of low vitality, such as fat, fascia, or tendon. The pus infiltrates the meshes of the cellular tissue, but if the process continue for some time it may collect and form distinct circumscribed abscesses which eventually point.

*Clinical Features.*—The inflammatory reaction in cases of diffuse cellulitis is severe, and is usually ushered in by a distinct chill or even a rigor, while the temperature rises to 103°, 104°, or 105° F. The pulse is proportionately increased in frequency,

and is small, feeble, and often irregular. The face is flushed, the tongue dry and brown, and the patient may become delirious, especially during the night. Leucocytosis is present in cases of moderate severity; in very mild cases the reaction may be insufficient to cause leucocytosis; while in very severe cases the virulence of the toxins prevents reaction taking place, and leucocytosis is absent.

The local manifestations vary with the relation of the seat of the inflammation to the surface. When the superficial cellular tissue is involved, the skin assumes a dark bluish-red colour, is swollen, œdematous, and the seat of burning pain. To the touch it is firm, hot, and tender. When the primary focus is in the deeper tissues, the general constitutional disturbance is aggravated, while the local signs are delayed, and only become prominent when pus forms and approaches the surface. It is not uncommon for blebs containing dark serous fluid to form on the skin. The inflammation frequently spreads along the line of the main lymphatic vessels of the part (*septic lymphangitis*), and may reach the lymphatic glands (*septic lymphadenitis*).

With the formation of pus the skin becomes soft and boggy at several points, and eventually breaks, giving exit to a quantity of thick, grumous discharge. Sometimes several small collections under the skin fuse, and a distinct abscess is formed, in which fluctuation can be detected. Occasionally gases are evolved in the tissues, giving rise to emphysema. It is very common for portions of fascia, ligaments, or tendons to slough, and this may often be recognised clinically by a peculiar crunching or grating sensation transmitted to the finger on making firm pressure on the part.

If it is not let out by incision, the pus, travelling along the lines of least resistance, tends to point at several places on the surface, or to open into joints or other cavities.

*Prognosis.*—The occurrence of *septicæmia* is the most serious risk, and it is in cases of diffuse suppurative cellulitis that this form of blood-poisoning assumes its most aggravated forms. The toxins of the streptococci are exceedingly virulent, and induce local death of tissue so rapidly that the protective emigration of leucocytes fails to take place. In some cases the passage of masses of free cocci in the lymphatics, or of septic emboli in the blood-vessels, leads to the formation of *pyæmic abscesses* in vital organs, such as the brain, lungs, liver, kidneys, or other viscera. *Hæmorrhage* from suppurative perforation of arterial or venous trunks may take place and prove dangerous to life.

*Treatment.*—The treatment of diffuse cellulitis is *early and free incision* of the affected area. It is not necessary, nor even advisable, to wait until there is evidence of pus formation before using the knife, as incision will limit, or may even prevent, suppuration. If one incision does not command the whole area involved, others must be made, care being taken that they are placed so as not to injure important vessels and nerves. The pus is gently squeezed from the meshes of the tissues, and, where it is deemed advisable, the whole surface of the wound may be sponged over with pure carbolic acid. Drainage tubes are inserted, or iodoform gauze lightly packed into the wound, and an ordinary antiseptic dressing applied, to be renewed at least once daily until granulations are formed and the risk of further spread is past.

In cases where the temperature remains raised, and other signs of septic absorption persist after incisions have been made, benefit may result from the *continuous irrigation* of the part by a slow, steady stream of a mild antiseptic lotion, at the body temperature, such as boracic acid or permanganate of potash. Frequent washing with sulphurous acid or peroxide of hydrogen (10 vols. strength) has been found to be of value in such cases.

The method of treating these cases by *continuous immersion* in a water-bath containing antiseptics has its advocates, but it is a method which is very liable to be misused and to do harm.

Elevation of the affected part diminishes the passive œdema and the pain ; but it is necessary to take care that it in no way interferes with drainage, and that it does not facilitate the spread of the pus farther up the limb. A suitably arranged splint adds to the comfort of the patient. The limb should be placed in the attitude which, in the event of stiffness resulting, will least interfere with its usefulness. The elbow, for example, should be flexed to a little less than a right angle ; at the wrist, the hand should be dorsiflexed and the fingers flexed slightly towards the palm.

The rapidity with which the process is arrested and repair takes place after prompt and vigorous treatment is often remarkable.

Massage, passive movement, hot and cold douching, and other measures, may be necessary to get rid of the chronic œdema, adhesions of tendons, and stiffness of joints which so often remain after cellulitis.

In all cases the toxæmia must be counteracted by the ad-

ministration of quinine, strychnine, salicylate of iron, alcoholic stimulants, and by suitable nourishment.

In cases due to infection by streptococci, anti-streptococcic serum should be used.

In a few rare cases amputation well above the seat of disease may, by removing the source of toxin production, offer the only means of saving the patient's life.

While the majority of surgeons continue to follow the lines of treatment mentioned above, it should be mentioned that Bier, of Bonn, advocates the employment of passive congestion in the treatment of septic lesions, such, for example, as acute suppuration in tendon sheaths (p. 62).

## Suppurative Cellulitis in Different Situations.

**Whitlow.**—The clinical term whitlow is applied to an acute inflammation, usually followed by suppuration, occurring in the connective-tissue planes of the fingers. The point of infection is often of a very trivial character—a pin-prick, a puncture caused by a splinter of wood, a scratch, or even an imperceptible lesion of the skin.

Several varieties of whitlow are recognised, but while it is convenient to describe them separately, it is to be clearly understood that clinically they merge one into another, and it is not always possible to determine in which connective-tissue plane a given whitlow has originated.

*The Purulent Blister.*—In the most superficial variety pus forms between the rete Malpighii and the stratum corneum of the skin, the latter being raised as a blister in which fluctuation can be detected (Fig. 13, *a*). This is commonly met with in the palm of the hand of labouring men, who have recently resumed work after a spell of idleness. When the pus forms in relation to the nail,—which corresponds to the stratum corneum,—it raises the nail also, and the yellow pus is often visible through it.

There is some local heat and discoloration, and considerable pain and tenderness, but little or no constitutional disturbance. Superficial lymphangitis may extend a short distance up the hand. By clipping away the raised epidermis and nail the pus is allowed to escape, and under an antiseptic dressing healing speedily takes place.

*Whitlow at the Nail Fold.*—This variety, which is met with among those who handle septic material, occurs in the sulcus between the nail and the skin, and is due to the introduction of

septic matter at the root of the nail (Fig. 13, *b*). A small focus of suppuration forms under the nail, with swelling and redness of the nail fold, causes intense pain and discomfort, which interfere with sleep, and produces a constitutional reaction out of all proportion to the local lesion.

To allow the pus to escape, it is necessary, under local anæsthesia, to cut away the nail fold as well as the portion of nail in the affected area, or, it may be, to remove the nail entirely. If only a small opening is made in the nail it is apt to be blocked by granulations.

*Subcutaneous Whitlow.*—In this variety the disease manifests itself as a cellulitis of the pulp of the finger (Fig. 13, *c*), which

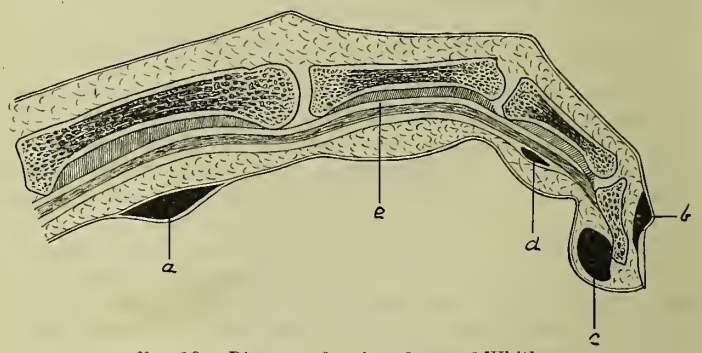



FIG. 13.—Diagram of various forms of Whitlow.

*a* = Purulent blister.
*b* = Suppuration at nail fold.
*c* = Subcutaneous whitlow.
*d* = Whitlow in sheath of flexor tendon (*e*).

sometimes spreads towards the palm of the hand. The finger becomes red, swollen, and tense, there is severe pain, which is usually worst at night and prevents sleep, and the part is extremely tender on pressure. When the palm is invaded, the swelling may be most marked on the back of the hand, the dense integument of the palm preventing the swelling from appearing on the front, until the pus is nearing the surface. The pus which forms may be under such tension that fluctuation cannot be detected. The patient is usually able to flex the finger to a certain extent without increasing the pain—a point which indicates that the tendon sheaths have not been invaded. The suppurative process may, however, spread to the tendon sheaths, or even to the bone. Sometimes the excessive tension and virulent toxins induce actual gangrene of the distal part, or

even of the whole finger. There is considerable constitutional disturbance, the temperature often reaching 101° or 102° F.

The treatment consists in making an incision over the centre of the most tender area, care being taken to avoid opening the tendon sheath lest the infection be conveyed to it. Moist dressings should be employed while the suppuration lasts. Carbolic fomentations, however, are to be avoided on account of the risk of inducing gangrene (p. 97).

*Whitlow of the Tendon Sheaths.*—In this form the main incidence of the disease is on the sheaths of the flexor tendons, but it is not always possible to determine whether the infection started there or spread thither from the subcutaneous cellular tissue (Fig. 13, *d*). In some cases both connective-tissue planes are involved. The affected finger (or fingers) becomes red, painful, and swollen, the swelling spreading to the back of the hand, which becomes soft and puffy. The involvement of the tendon sheath is usually indicated by the patient being unable to flex the finger and by the pain being increased when he attempts to do so. On account of the anatomical arrangement of the tendon sheaths the process may spread into the forearm—directly in the case of the thumb and little finger, and after invading the palm in the case of the other fingers (Fig. 14)—and there give rise to a diffuse suppurative cellulitis which may result in sloughing of fasciæ and tendons. When the suppuration spreads into the common flexor sheath under the anterior annular ligament it is not uncommon for the intercarpal and wrist joints to become implicated. Impaired movement of tendons and joints is, therefore, a common sequel to this variety of whitlow.



Fig. 14.—Whitlow in Sheath of Flexor Tendon of Index-Finger with Abscess spreading into Palm. The white appearance of the skin is the result of poulticing.

The *treatment* consists in making free incisions, with the aid of a local anæsthetic, into the inflamed or suppurating areas, and to diminish the risk of subsequent adhesions and of sloughing of the tendons, such incisions should be made early. Incisions in the fingers should be made in the middle line to avoid the digital vessels and nerves. When incisions into the

palm are called for they should be made over the metacarpal bones to avoid the digital vessels and nerves. If pus has spread under the anterior annular ligament this structure should be divided by an incision placed over the middle of the front of the wrist. Bier, of Bonn, has recently advocated the treatment of this variety of whitlow by passive congestion produced by applying a rubber band above the inflamed area, tightly enough to cause a marked congestion without at the same time rendering the hand cold or increasing the pain. The congestion is kept up for at least ten hours a day, and in severe cases for as long as twenty or twenty-two hours. If pus forms it is let out by a small puncture, but no drain or packing is used. Passive and active movements are carried out daily while the band is off. Bier claims for this treatment that the pain is markedly diminished; that the inflammatory process is localised; that sloughing of tendons is usually prevented, and if it occurs the sloughs separate quickly; and that the functional results are better than those obtained by the older method. Passive movements and massage must be commenced as early as possible and be perseveringly employed to prevent the formation of adhesions and resulting stiffness. Care must be taken, however, that these manipulations do not again light up the inflammation.

*Subperiosteal Whitlow.*—This form is usually merely an extension of the subcutaneous or of the thecal variety. In some cases, however, the inflammation appears to begin in the periosteum—usually of the terminal phalanx. It may lead to necrosis of a portion of a phalanx, or even of an entire bone. This is usually recognised by the persistence of suppuration long after the acute symptoms have passed off, and by feeling bare bone with the probe. In such cases one or more of the joints are usually implicated also, and lateral mobility and grating may be elicited on manipulation. Recovery does not take place until the dead bone is removed, and the usefulness of the finger is often seriously impaired by fibrous or bony ankylosis. This may render amputation advisable when a stiff finger is likely to interfere with the patient's occupation.

*Cellulitis of the forearm* is usually a sequel to one of the deeper varieties of whitlow. Serious impairment of usefulness in the limb often results from sloughing of fasciæ and tendons or from adhesions.

In the *region of the elbow-joint* cellulitis is common around the olecranon process. It may originate as an inflammation of the olecranon bursa, or may invade the bursa secondarily. In exceptional cases the elbow-joint is also involved.

Cellulitis of the *axilla* may originate in an infected wound of the hand which has been followed by suppuration in the lymphatic glands, or it may spread from a septic wound on the chest wall or in the neck. In some cases it is impossible to discover the primary seat of infection. A firm, brawny swelling forms in the arm-pit and extends on to the chest wall. It is attended with great pain, which is increased on moving the arm, and there is marked constitutional disturbance. When suppuration occurs its spread is limited by the attachments of the axillary fascia, and the pus tends to burrow on to the chest wall between the pectoral muscles, and upwards towards the shoulder-joint, into which it may burst and so give rise to a septic arthritis. When the pus forms in the axillary space, the treatment consists in making free incisions which should be placed on the thoracic side of the axilla to avoid the axillary vessels and nerves. If the pus spreads on to the chest wall the abscess should be opened below the clavicle by Hilton's method.

Conditions similar to whitlow occur in the *toes* and *sole of the foot*, but with much less frequency than in the fingers and hand.

In the *region of the ankle* cellulitis is not common; but *around the knee* it frequently occurs in relation to the prepatellar bursa and in the popliteal lymphatic glands, and may endanger the knee-joint. It is also met with in the *groin* following on inflammation and suppuration of the glands, and cases are recorded in which the sloughing process has implicated the femoral vessels and led to secondary hæmorrhage.

Cellulitis of the scalp, orbit, neck, pelvis, and perineum will be considered with the diseases of these regions.

## Chronic Suppuration.

While it is true that a chronic pyogenic abscess is sometimes met with—for example, in the breast and in the marrow of long bones—in the great majority of instances the formation of a chronic or cold abscess is the result of the action of the tubercle bacillus. It is, therefore, more convenient to study this form of suppuration with tuberculosis, and the reader is referred to the chapter on that subject.

## Local Results of Suppuration when Healing is Prevented—Sinus and Fistula.

A **Sinus** is a track leading from a focus of suppuration in the tissues to a cutaneous or mucous surface. There are two varieties

of sinus met with clinically — the septic, and the tuberculous sinus.

A *septic sinus* usually represents the track by which the discharge escapes from an abscess cavity which has been prevented from closing completely. The obstacle to closure may be the presence of a foreign body, such as a piece of dead bone, a septic ligature, or a bullet in the abscess cavity, and this may act mechanically or by keeping up a discharge which must find an exit. In other cases—for example, where the sinus passes through a muscle—closure may be prevented by the constant movement of the part. The sinus is lined by granulation tissue, and when a foreign body is present a mass of redundant granulations often projects from the external opening. In a sinus of long standing there is often a considerable amount of scar tissue around it, the contraction of which drags the opening of the sinus below the level of the surrounding skin. The *treatment* in these cases is the removal of the cause, by enlarging the opening so as to be able to remove any foreign substance and to permit of disinfection as well as of thorough drainage. Any muscles through or between which the sinus passes must be kept at rest by suitable splints, or by division of their fibres. The sinus may be scraped, and treated with pure carbolic acid or the thermo-cautery, and then stuffed with iodoform worsted, so as to encourage healing from the bottom. When the healing of a sinus is likely to be followed by contraction causing disfigurement—for example, in a sinus over the lower jaw associated with a carious tooth—it may be treated by complete excision, the raw surfaces left being approximated by stitches.

The *tuberculous sinus* fails to close because of the presence of tuberculous tissues in its walls. As a rule the primary focus of tubercle in bone, joint, or gland is still active, and the sinus is a necessary avenue for the escape of discharge. These sinuses, which are often long and tortuous, are treated by thorough removal of all the tuberculous tissue from which they originate and by which they are lined, and by thorough disinfection with carbolic acid or some other powerful and penetrating antiseptic. Packing with iodoform worsted is a useful form of dressing. Persistent tuberculous sinuses may sometimes close after being repeatedly subjected to the Röntgen rays.

A **Fistula** is an abnormal canal passing from a mucous surface to the skin or to another mucous surface. Fistulæ resulting from suppuration usually occur near the natural openings of

mucous canals—for example, on the cheek, as a salivary fistula; beside the angle of the eye, as a lachrymal fistula; near the ear, as a mastoid fistula; or close to the anus, as a fistula-in-ano. Intestinal fistulæ are sometimes met with in the abdominal wall after strangulated hernia, operations for appendicitis, tuberculous peritonitis, and other conditions. In the perineum they frequently complicate stricture of the urethra.

Fistulæ also occur between the bladder and vagina (*vesico-vaginal fistula*), or between the bladder and the rectum (*recto-vesical fistula*).

The guiding principle in treating a fistula is to enable the discharge to pass more readily by the natural than by the abnormal route. When this is done, spontaneous closure of the fistulous opening tends to take place in most cases, but in others, plastic operations are necessary to effect a cure.

*Congenital fistulæ*, such as occur in the neck from imperfect closure of branchial clefts, or in the abdomen from unobliterated fœtal ducts, such as the urachus or Meckel's diverticulum, will be described in their proper places.

## Fevers due to the Action of Pyogenic Bacteria.

We have here to consider certain fevers, Sapræmia, Septicæmia, and Pyæmia, which, although their clinical manifestations may vary, are all associated with the action of the same forms of bacteria. They may occur separately or in combination, or one may follow on another.

**Sapræmia**, or septic intoxication, is the name applied to a form of septic poisoning resulting from the absorption into the blood of the toxic products of pyogenic bacteria. These products are of the nature of alkaloids. They act immediately on their entrance into the circulation, and produce effects in direct proportion to the amount absorbed. As the poison is gradually eliminated from the body the symptoms abate, and if no more is introduced they disappear. Sapræmia in these respects, therefore, is comparable to poisoning by any other form of alkaloid, such as strychnine or morphine.

*Clinical Features.*—The symptoms of sapræmia seldom manifest themselves within twenty-four hours of an operation or injury, because it takes some time for the bacteria to produce a sufficient dose of their poisons. The onset of the condition is marked by a feeling of chilliness, sometimes amounting to a rigor, and a rise of the temperature to 102°, 103°, or 104° F., with slight morning

remissions (Fig. 5). The heart's action is markedly depressed, and the pulse is soft and compressible. The appetite is lost, the tongue dry and covered with a thin brownish-red fur, so that it has the appearance of "dried beef." The urine is scanty and loaded with urates. In severe cases vomiting of dark coffee-ground material and diarrhœa are often prominent features. Death is usually impending when the skin becomes cold and clammy, the mucous membranes livid, the pulse feeble and fluttering, the discharges involuntary, and when a low form of muttering delirium is present.

A local focus of septic infection is always present,—it may be an abscess, a septic compound fracture, or a septic infection of the cavity of the uterus, for example, an incomplete abortion or a retained portion of placenta.

*Prognosis.*—As the symptoms are due to definite doses of the toxin, the prognosis depends upon the amount already absorbed, the resisting powers of the patient, and the possibility of arresting further absorption. If the decomposing material is at once removed, and if a lethal dose of the poison has not already entered the circulation, the prognosis is good, and the symptoms begin to subside as soon as the supply is cut off.

*Treatment.*—The first and clearest indication in treatment is the immediate and complete removal of the infected material. The wound must be freely opened, all blood-clot, discharge, or necrosed tissue thoroughly removed, and the area disinfected, by washing with sterilised salt solution, peroxide of hydrogen, or boracic acid. Stronger lotions are to be avoided as being likely to depress the tissues on the surface of the wound, and so to interfere with protective phagocytosis. On account of its power of neutralising toxins, iodoform is a useful application in these cases, and is best employed by packing the wound with iodoform gauze, and treating it by the open method, if this is possible.

To aid the patient in getting rid of the poison already absorbed, general stimulants are useful. In serious cases alcohol in the form of brandy or whisky, in hourly half-ounce doses; hypodermic injections of strychnine (1/60th to 1/30th gr. every hour), digitalin (1/100th gr. every hour), or adrenalin (10 to 15 minims of a 1-1000 solution), may be required. The kidneys should be flushed by administering large quantities of bland fluids by the mouth or rectum. The vomiting can sometimes be checked by effervescing drinks such as citrate of caffein, or by dilute hydrocyanic acid and bismuth. In severe cases, and especially when the vomited matter resembles coffee-grounds from admixture with altered blood,—the so-called post-operative

hæmatemesis,—the best means of arresting the vomiting is by washing out the stomach. The patient must be fed with nourishing and easily assimilated food. The infusion of saline solution into the veins is sometimes useful in hastening the elimination of the toxins.

**Chronic Sapræmia or Hectic Fever.**—Hectic fever differs from acute sapræmia merely in degree. It usually occurs in connection with tuberculous conditions such as bone or joint disease, psoas abscess, or empyema, which have opened externally, and have thereby become infected with pyogenic organisms. It is gradual in its development, and is of a mild type throughout.

The pulse is small, feeble, and compressible, and the temperature rises in the afternoon or evening to 102° or 103° F. (Fig. 6), the



Fig. 15.—Extreme Emaciation accompanying Hectic Fever secondary to Sacro-iliac Disease in a boy aged 8, who subsequently recovered.

cheeks becoming characteristically flushed. In the early morning the temperature suddenly falls to normal or below it, and the patient breaks into a profuse perspiration which leaves him pale, weak, and exhausted. He becomes rapidly and markedly emaciated (Fig. 15), even although in some cases the appetite remains good and is even voracious.

The poisons circulating in the blood produce *waxy degeneration* in certain viscera, notably the liver, spleen, kidneys, and intestines. The process begins in the arterial walls and spreads thence to the connective-tissue structures, causing marked enlargement of the affected organs. Albuminuria, ascites, œdema of the lower limbs, clubbing of the fingers, and diarrhœa are among the most prominent symptoms of this condition.

The *prognosis* in hectic fever depends on the completeness with which the further absorption of toxins can be prevented. In many cases this can only be effected by an operation which provides for free drainage, and, if possible, the removal of infected

tissues. The resulting wound is best treated by the open method. Even advanced waxy degeneration does not contra-indicate this line of treatment, as the diseased organs usually recover if the focus from which absorption of septic material is taking place be completely eradicated.

**Septicæmia.**—This form of septic poisoning is the result of the action of pyogenic bacteria, which not only produce their toxins at the primary seat of infection, but themselves enter the blood-stream and are carried to different viscera, where they settle and produce further effects.

*Clinical Features.*—There may be an incubation period of some hours between the infection and the first manifestation of acute septicæmia. In such conditions as acute osteomyelitis or acute perforation peritonitis we see the most typical clinical pictures of this condition. The onset is marked by a chill, or a rigor, which may be repeated, while the temperature rises to 103° or 104° F. In very severe cases the temperature may be subnormal throughout. The virulence of the toxins may prevent leucocytosis. It is in the general appearance of the patient and in the condition of the pulse that we have our best guides as to the severity of the condition. If the pulse remains firm, full, and regular, and does not exceed 110 or even 120, while the temperature is moderately raised, the outlook is hopeful; but when the pulse becomes small and compressible, and reaches 130 or more, especially if at the same time the temperature is low, a grave prognosis is indicated. The tongue is often dry and coated with a black crust down the centre, while the sides are red. It is a good omen when the tongue becomes moist again. Thirst is most distressing, especially in septicæmia of intestinal origin. Persistent vomiting of dark-brown material is often present, and diarrhœa with blood-stained stools is not uncommon. The urine is small in amount, and contains a large proportion of urates. As the disease advances, the respiration becomes shallow and laboured, the face of a dull ashy grey, the nose pinched, and the skin cold and clammy. Capillary hæmorrhages sometimes take place in the skin or mucous membranes; and in a certain proportion of cases cutaneous eruptions simulating those of scarlet fever or measles appear, and are apt to lead to errors in diagnosis. In other cases there is slight jaundice. The mental state is often one of complete apathy, the patient failing to realise the gravity of his condition; sometimes there is delirium.

The *prognosis* is always grave, and depends on the possibility of completely eradicating the focus of infection, and the reserve

force the patient has to carry him over the period during which he is eliminating the poison already in circulation.

It has been suggested by Watson-Cheyne that the anti-streptococcic serum should be injected as a prophylactic before operation in cases where there is reason to fear streptococcal infection, and where absolute asepsis cannot be ensured, as in the mouth or rectum.

*Treatment.*—The same measures are adopted as in the treatment of sapræmia, but they are less likely to be successful owing to the organisms having entered the circulation. Where possible the primary focus of infection should be dealt with.

**Pyæmia** is a form of septic poisoning characterised by the development of secondary foci of suppuration in different parts of the body by metastasis. Toxins are thus introduced into the blood, not only at the primary seat of infection, but also from each of these metastatic collections. Like septicæmia, this condition is due to pyogenic bacteria, the *streptococcus pyogenes* being the commonest organism found. The primary infection is usually in a surface wound, but cases occur in which the point of entrance of the bacteria is not discoverable. The dissemination of the organisms takes place through the medium of septic emboli which form in a thrombosed vein in the vicinity of the original lesion, and breaking loose are carried thence in the blood-stream. These emboli lodge in the minute vessels of the lungs, spleen, liver, kidneys, pleura, brain, synovial membranes, or cellular tissue, and the bacteria they contain give rise to inflammatory changes which end in suppuration. Secondary abscesses are thus formed in those parts, and these in turn may be the starting-point of new emboli which give rise to fresh areas of pus formation. The organs above named are the commonest situations of pyæmic abscesses, but these may also occur in the bone marrow, the substance of muscles, the heart and pericardium, lymphatic glands, subcutaneous tissue, or, in fact, in any tissue of the body. Septic organisms circulating in the blood are prone to lodge on the valves of the heart and give rise to endocarditis.

*Clinical Features.*—Before antiseptic surgery was practised, pyæmia was a common complication of surgical wounds. In the present day it is not only infinitely less common, but appears also to be of a less severe type. Its rarity and its mildness may be related as cause and effect, because it was formerly found that pyæmia contracted from a pyæmic patient was more virulent than that from any other source.

In contrast with sapræmia and septicæmia, pyæmia is late of

developing, and it seldom begins within a week of the primary infection. The first sign is a violent rigor lasting for perhaps half an hour, during which time the temperature rises to 103°, 104°, or 105° F. In the course of an hour it begins to fall again, and the patient breaks into a profuse sweat. The temperature may fall several degrees, but seldom reaches the normal. In a few days there is a second rigor with rise of temperature, and another remission, and such attacks may be repeated at diminishing intervals during the course of the illness (Figs. 8 and 9). The pulse is soft, and tends to remain abnormally rapid even when the temperature falls nearly to normal.

The face is flushed and wears a drawn, anxious expression, and the eyes are bright. A characteristic sweetish odour, which has been compared to that of new-mown hay, can be detected in the breath and may pervade the patient. The appetite is lost; there may be sickness and vomiting and profuse diarrhœa; and the patient emaciates rapidly. The skin is continuously hot and has often a peculiar pungent feel. Patches of erythema (redness) sometimes appear scattered over the body. The skin may assume a dull sallow or earthy hue, or a bright yellow icteric tint may appear. The conjunctivæ also may be yellow. In the later stages of the disease the pulse becomes small and fluttering; the tongue becomes dry and brown; sordes collect on the teeth; and a low-muttering form of delirium supervenes.

Secondary infection of the parotid gland frequently occurs and gives rise to a suppurative parotitis. This condition is associated with severe pain, gradually extending from behind the angle of the jaw on to the face. There is also swelling over the gland, and eventually suppuration and sloughing of the gland tissue and overlying skin.

Secondary abscesses in the lymphatic glands, subcutaneous tissue, or joints are often very insidious and painless in their development, so that they may only be discovered by the swelling which results. When the abscess is evacuated, healing often takes place with remarkable rapidity, and with little interference with function.

*Prognosis.*—While the prognosis in acute pyæmia is always grave, it is much less hopeless than it once was, a considerable proportion of the patients recovering. In acute cases the disease proves fatal in ten days or a fortnight, death being due to toxæmia. Chronic cases often run a long course, lasting for weeks or even months, and prove fatal from exhaustion and waxy disease following on prolonged suppuration.

*Treatment.*—The rational treatment is in the first place to

arrest the dissemination of the infective material from the primary source of infection. In some cases an attempt may be made to interrupt the channel along which the septic emboli spread by ligaturing or resecting the main vein of the affected part. This is seldom feasible, however, except in the case of the internal jugular vein for lateral sinus phlebitis. The wound must be thoroughly disinfected, its surface sponged with undiluted carbolic acid, and then packed with iodoform gauze or worsted until granulations form. When this is impracticable or inefficient, amputation may be called for.

Secondary abscesses must be opened and drained whenever possible.

The constitutional treatment is conducted on the same general lines as in other forms of septic infection. Quinine in large doses has a special reputation as an internal antiseptic and antipyretic in this disease.

# CHAPTER VI.

## ULCERATION AND ULCERS.

Definitions—Clinical examination of an ulcer—The healing sore.—Classification of ulcers—A. According to cause: *Traumatism, Imperfect circulation, Imperfect nerve-supply, Constitutional causes*—B. According to condition: *Healing, Stationary, Spreading.*—Treatment—Skin-Grafting.

The process of *ulceration* may be defined as the molecular or cellular death of tissue taking place on a free surface. It is essentially of the same nature as the process of suppuration, only that the purulent discharge, instead of collecting in a closed cavity and forming an abscess, at once escapes on the surface.

An *ulcer* is an open wound or sore in which there are present certain conditions tending to prevent it undergoing the natural process of repair. Of these, one of the most important is the presence of pathogenic bacteria, which by their action not only prevent healing, but so irritate and destroy the tissues as to lead to an actual increase in the size of the sore. Interference with the nutrition of a part by œdema or venous congestion may impede healing; as may also induration of the area surrounding an ulcer, by preventing the contraction which is such an important factor in repair. Defective innervation such as occurs in cases of spinal disease or injury, in infantile paralysis, and in other nervous conditions, also plays an important part in delaying repair in ulcers. In certain constitutional conditions too—for example, Bright's disease, diabetes, or syphilis—the vitiated state of the tissues is an impediment to repair. Mechanical causes such as unsuitable dressings or ill-fitting appliances may also act in the same direction.

**Clinical Examination of an Ulcer.**—In examining any ulcer we observe—(1) Its *base* or *floor*, noting the presence or absence

of granulations, their disposition, size, colour, vascularity, and whether they are depressed or elevated in relation to the surrounding parts. (2) The *discharge* as to quantity, consistence, colour, composition, and odour. (3) The *edges*, noting particularly whether or not the marginal epithelium is attempting to grow in over the surface; also their shape, regularity, thickness, and whether undermined or overlapping, everted or depressed. (4) The *surrounding tissues* as to whether they are congested, œdematous, inflamed, indurated, or otherwise. (5) Whether or not there is *pain* or tenderness in the raw surface or its surroundings. (6) The *part of the body* on which it occurs, because certain ulcers have special seats of election—for example, the varicose ulcer in the lower third of the leg, the perforating ulcer on the foot, and so on.

**The Healing Sore.**—When a portion of skin has been excised aseptically—for example, in removing a small cutaneous tumour—the raw surface left is soon covered over with a layer of coagulated blood and lymph. In the course of a few days this is replaced by the growth of *granulations*, which are of uniform size, of a pinkish-red colour, and moist with a slight serous exudation containing a few dead leucocytes. They grow until they reach the level of the surrounding skin, and so fill the gap with a fine velvety mass of granulation tissue. At the edges the young epithelium may be seen spreading in over the granulations as a fine bluish-white pellicle, which gradually covers in the sore, becoming paler in colour as it thickens, and eventually forming the smooth, non-vascular covering of the cicatrix. There is neither pain nor fever, and the surrounding parts are healthy.

This may be taken as the ideal form of ulcer, and may conveniently be used as a type with which to compare the ulcers seen at the bedside, so that we may determine how far, and in what particulars, these differ from the type; and that we may in addition recognise the conditions which have to be counteracted before they assume the characters of the typical healing sore.

For purposes of contrast we may look at the characters of an ulcer in which bacterial infection has taken place. Suppose the raw surface to have become infected with virulent pyogenic bacteria, the layer of coagulated blood and lymph becomes liquefied and is thrown off. Instead of granulations being formed, the tissues exposed on the floor of the ulcer are destroyed by the bacterial toxins, with the formation of minute sloughs and a quantity of pus.

The discharge is profuse, thin, acrid, and offensive, and consists of pus, broken-down blood-clot and sloughs. The edges are inflamed, irregular, and ragged, showing no sign of growing epithelium,—on the contrary, the sore may be actually increasing in area by the breaking-down of the tissues at its margins. The surrounding parts are in a state of inflammation—hot, red, swollen, and œdematous; and there is pain and tenderness both in the sore itself and in the parts around.

**Classification of Ulcers.**—The nomenclature of ulcers is at present much involved and gives rise to great confusion, chiefly for the reason that no one basis of classification has been adopted. Thus some ulcers are named according to the causes at work in producing or maintaining them—for example, the traumatic, the septic, and the varicose ulcer; some from the constitutional element present, as the tuberculous, the syphilitic, the gouty, and the diabetic ulcer; and others according to the condition in which they happen to be when seen by the surgeon, such as the weak, the inflamed, the callous, and the healing ulcer.

So long as we retain many of these names it will be impossible to find a single basis for classification; and yet many of the terms are so convenient, so descriptive, and so generally understood that it is undesirable to abolish them. We must therefore remain content with a clinical arrangement of ulcers—it cannot be called a classification,—considering any given ulcer from two points of view: first, its *cause*, and second, its *present condition*. This method of studying ulcers has the practical advantage that it furnishes us with the main indications for treatment as well as for diagnosis,—the cause must be removed, and the condition so modified as to convert the ulcer into an aseptic healing sore.

A. **Arrangement of Ulcers according to their Cause.**—It has already been indicated that the main cause of ulceration is the action of pyogenic bacteria, and that in addition there is usually some other factor present which determines the special characters of the ulcer and the clinical variety to which it belongs.

*Ulcers due to Traumatism.*—Traumatism in the form of a *crush* or *bruise* is a frequent cause of ulcer formation, acting either by directly destroying the skin, or by so diminishing its vitality that it is rendered a suitable soil for bacteria. If these gain access, in the course of a few days the damaged area of skin becomes of a greyish colour, large blebs form over it, and it dies and separates, leaving a raw surface with feeble

granulations, and with portions of sloughy tissue adherent to it.

*Burns and Scalds* act in a similar way. Exposure to the Röntgen rays has been followed by a severe form of ulcer.

The *Pressure* of improperly padded splints or other appliances may so far interfere with the local circulation of the part pressed upon that an ulcer is formed. This is most liable to occur in patients who suffer from some nerve lesion—such, for example, as infantile paralysis, or injury of the spinal cord or nerve-trunks. Splint-pressure sores are situated over bony prominences, such as the malleoli, the condyles of the femur or humerus, the head of the fibula, the dorsum of the foot, or the base of the fifth metatarsal bone. On removing the splint the skin of the part pressed upon is found to be of a red or pink colour, with a pale grey patch in the centre, which eventually sloughs and leaves an ulcer.



Fig. 16.—Chronic Ulcer of Leg.

Similar ulcers are occasionally produced artificially by malingerers and hysterical subjects.

Pressure also plays a part in the production of *bed-sores*.

*Ulcers due to Imperfect Circulation.*—Imperfect circulation is an important causal factor in ulceration, especially when it is the *venous return* which is defective. This is best illustrated in the so-called *leg ulcer*, which occurs most frequently on the front and inner aspects of the lower third of the leg (Fig. 16). At this point the anastomosis between the superficial and deep veins of the leg is less free than elsewhere, so that the extra stress thrown upon the surface veins interferes with the nutrition of the skin (Hilton). The importance of imperfect venous return in the causation of such ulcers is evidenced by the fact that all methods of treatment are unavailing unless the patient be confined to bed and the limb elevated. In a considerable number of cases, but by no means in all, this form of ulcer is associated with the presence of varicose veins, and in such cases it is spoken

of as the *varicose ulcer*. Any slight injury or irritation of the devitalised area is liable to permit of septic infection and lead to ulceration. Dermatitis and eczema are common in association with varicose veins, and the scratching or rubbing of the part is very liable to cause a breach of the surface and permit of infection. Such ulcers may also originate from the bursting of a small peri-phlebitic abscess.

Varicose veins in immediate relation to the base of a large chronic ulcer usually become thrombosed, and in time are reduced to fibrous cords, and therefore in such cases hæmorrhage is not a common complication. In smaller and more superficial ulcers, however, the destructive process is liable to implicate the wall of the vessel before the occurrence of thrombosis, and to lead to profuse and often dangerous bleeding.

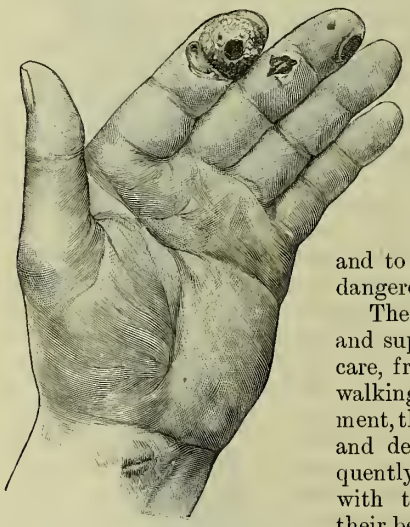


Fig. 17.—Trophic Ulcers of Fingers following Division of Median Nerve above Wrist.

These ulcers are at first small and superficial, but from want of care, from continued standing or walking, or from injudicious treatment, they gradually become larger and deeper. They are not infrequently multiple, and this, together with their depth, may lead to their being mistaken for syphilitic ulcers. The base of the ulcer is covered with imperfectly formed, soft, œdematous granulations, which give off a thin sero-purulent discharge. The edges are slightly inflamed, and show no evidence of healing. The parts around are usually pigmented and slightly œdematous, and as a rule there is little pain. This variety of ulcer is particularly prone to pass into the condition known as callous.

In *anæmic* patients, especially young girls, ulcers are occasionally met with which have many of the clinical characters of those associated with imperfect venous return. They are very slow to heal, and tend to pass into the condition known as weak.

*Ulcers due to Interference with Nerve-supply.*—Any inter-

ference with the nerve-supply of the superficial tissues predisposes to ulceration. For example, *trophic* ulcers are liable to occur in injuries or diseases of the spinal cord, in cerebral paralysis, in limbs weakened by infantile paralysis, in ascending or peripheral neuritis, or after injuries of nerve-trunks (Fig. 17). It is believed by some that the common chronic ulcer of the leg is dependent upon altered trophic innervation, as well as upon changes in the venous circulation.

The *acute bed-sore* (p. 110) is a rapidly-progressing form of ulceration, often amounting to gangrene, of portions of skin



FIG. 18.—Perforating Ulcer on the Foot of a woman æt. 62, who suffered from Diabetes.

exposed to pressure when their trophic nerve-supply has been interfered with.

The ordinary *pressure bed-sore* (p. 110), although not necessarily associated with defective nerve-supply, may be so.

The *perforating ulcer of the foot* is a peculiar type of sore which occurs in association with the different forms of peripheral neuritis, and with various lesions of the brain and spinal cord, such as general paralysis, locomotor ataxia, or syringo-myelia. It also occurs in patients suffering from glycosuria (Fig. 18). Perforating ulcer is met with most frequently under the head of the metatarsal bone of the great toe. A callosity forms and

suppuration occurs under it, the pus escaping through a small hole in the centre. So long as the patient continues to go about, the process slowly and gradually spreads deeper and deeper, till eventually the bone or joint is reached, and becomes implicated in the destructive process—hence the term "perforating ulcer." The flexor tendons are sometimes destroyed, the toe being dorsiflexed by the unopposed extensors. The depth of the track being so disproportionate to its superficial area, the condition closely simulates a tuberculous sinus, for which it is liable to be mistaken. The raw surface is absolutely insensitive, so that the probe can be freely employed without the patient even being aware of it or suffering the least discomfort—a significant fact in diagnosis. The cavity is filled with effete and decomposing epidermis which has a most offensive odour. The chronic and intractable character of these ulcers is due to interference with the trophic nerve-supply to the parts, and to the fact that the epithelium of the skin grows in and lines the track leading down to the deepest part of the ulcer and so prevents closure. While they are commonest on the sole of the foot and other parts subjected to pressure, perforating ulcers are met with on the sides and dorsum of the foot and toes, on the hands, and on other parts where no pressure has been exerted. It is to be borne in mind that ulcers occur in the foot under callosities independently of any nerve lesion. Although very slow to heal, they do not show the same tendency to burrow and persist as the perforating ulcer does.

The *tuberculous ulcer*, so often seen in the neck, in the vicinity of joints, or over the ribs and sternum, usually results from the bursting through the skin of a tuberculous abscess. The base is soft, pale, and covered with feeble granulations and grey shreddy sloughs. The edges are of a dull blue or purple colour, and gradually thin out towards their free margins, and in addition are characteristically undermined, so that a probe can be passed for some distance between the floor of the ulcer and the thinned-out edges. Thin, devitalised tags of skin often stretch from side to side of the ulcer. The outline is irregular; small perforations often occur through the skin, and a thin, watery discharge, containing grey shreds of tuberculous debris, escapes.

The *syphilitic ulcer* is usually formed by the breaking down of a cutaneous or subcutaneous gumma in the tertiary stage of syphilis. When the gummatous tissue is first exposed by the destruction of the skin or mucous membrane covering it, it appears as a tough greyish slough, compared to "wash leather," which slowly separates and leaves a more or less circular, deep,

punched-out gap which shows a few feeble unhealthy granulations and small sloughs on its floor. The edges are raised and indurated; and the discharge is thick, glairy, and peculiarly offensive. The parts around the ulcer are congested and of a dark-brown colour. There are usually several such ulcers together, and as they tend to heal at one part while they spread at another, the affected area assumes a sinuous or serpiginous outline. Syphilitic ulcers may be met with in any part of the body, but are most frequent in the upper part of the leg (Fig. 19), especially around the knee-joint in women, and over the ribs and sternum. On healing they usually leave a depressed and adherent cicatrix.

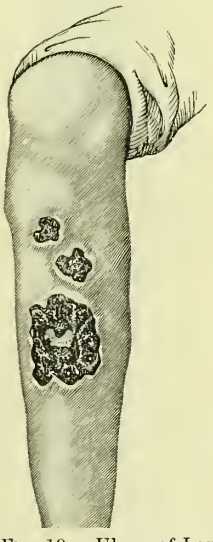


Fig. 19.—Ulcers of Leg in a patient suffering from Inherited Syphilis.

*Bazin's Disease.*—This term is applied to an affection of the skin and subcutaneous tissue which bears certain resemblances both to tuberculosis and to syphilis. It is met with almost exclusively between the knee and the ankle, and it usually affects both legs. It is commonest in young women of delicate constitution, in whose family history there is usually marked evidence of a tuberculous taint. The patient often presents other lesions of a tuberculous character, notably enlarged cervical glands and phlyctenular ophthalmia. The tubercle bacillus has, however, rarely been found in the lesions of Bazin's disease.

The condition begins by the formation in the skin and subcutaneous tissue of dusky or livid nodules of induration, which soften and ulcerate, forming small open sores with ragged and undermined edges, not unlike those resulting from the breaking down of superficial syphilitic gummata. Fresh crops of nodules appear in the neighbourhood of the ulcers, and in turn break down. While in the nodular stage the affection is sometimes painful, but with the formation of the ulcers the pain subsides. The disease is peculiarly intractable, no particular line of treatment yielding satisfactory results. After having lasted for several years, however, the condition usually undergoes spontaneous cure.

Treatment is directed towards improving the general health, and the patient should not be confined to bed. Locally, the X-rays may be employed.

The *scorbutic ulcer* occurs in patients suffering from scurvy, and is characterised chiefly by its marked tendency to bleed.

In *gouty* patients small ulcers which are exceedingly irritable and painful are liable to occur.

Other ulcers related to special morbid diatheses need not be specified here.

*Ulcers associated with Malignant Disease.*—Certain malignant tumours, such as scirrhus of the breast, epithelioma of the tongue or lip, and some sarcomata, frequently invade the skin or mucous membrane, and appear on the surface as open, vascular sores. These are sometimes spoken of as malignant ulcers, but as they are essentially different in their nature from all other forms of ulcers, and call for totally different treatment, it is best to consider them along with the tumours with which they are associated. Rodent ulcer, which is one form of cancer of the skin, will be discussed with tumours of the skin. It will be pointed out later that long-standing ulcers are liable to become the seat of malignant disease.

B. **Arrangement of Ulcers according to their Condition.**—Having arrived at an opinion as to the cause of a given ulcer, and placed it in one or other of the preceding groups, the next question to ask one's self is, "In what condition do I find it at the present moment?"

For practical purposes it may be said that any ulcer is in one of three states—healing, stationary, or spreading; although it is not uncommon to find healing going on at one part while the ulcer is extending at another.

*The Healing Condition.*—The process of healing in an ulcer has already been studied, and we have learned that it takes place by the formation of granulation tissue, which becomes converted into connective tissue, and is covered over by epithelium growing in from the adjacent skin edges.

Those which are *stationary*—that is, neither healing nor spreading—may be in one of several conditions.

*The Weak Condition.*—Any ulcer may get into a weak state from receiving a blood-supply which is defective either in quantity or in quality. The granulations on the base are small and smooth, and of a pale yellow or grey colour. The discharge is small in amount, and consists only of thin serum and a few pus cells. This dries on the edges and forms scabs which interfere with the growth of epithelium.

Should the part become œdematous either from general causes, such as heart, kidney, or liver disease, or from local

causes, such as varicose veins, the granulations share in the œdema, and a large quantity of thin, serous discharge escapes, but no healing takes place.

The excessive use of moist dressings leads to a third variety of weak ulcer—namely, one in which the granulations become large, soft, pale, and flabby, projecting beyond the level of the skin and overlapping the edges, which become pale and sodden and cease to grow. This constitutes what is popularly known as "proud flesh." The same condition may arise when induration around prevents contraction of the sore.

*The Callous Condition.*—This condition is usually met with in ulcers on the lower third of the leg, and is often associated with the presence of varicose veins. The want of healing is mainly due to impeded venous return and to the œdematous and indurated condition of the parts around. This induration of the surrounding tissues results from coagulation and partial organisation of the inflammatory effusion, and prevents the necessary contraction of the sore. The base of a callous ulcer lies at some distance below the level of the swollen, thickened, and white edges, and presents a glazed appearance, such granulations as are present being unhealthy and irregular. The characteristic discharge is a thin, serous fluid, mixed with pus, and having a foul odour. Unless when inflamed, pain is not a prominent feature. The sufferers from this variety of ulcer are chiefly met with in hospital practice.



FIG. 20.—Tibia and Fibula, illustrating the Changes associated with Chronic Ulcer of the Leg.

(Specimen in Professor Annandale's collection.)

The prolonged hyperæmia of the tissues in relation to a callous ulcer of the leg often leads to peculiar changes in the underlying bones. The periosteum is abnormally thick and vascular, the superficial layers of the bone become injected and porous, and the bones, as a whole, are thickened. In the macerated bone "the surface is covered with irregular, stalactite-like processes or foliaceous masses, which, to a certain extent, follow the line of attachment of the interosseous membrane and of the intermuscular

septa" (Cathcart) (Fig. 20). When the whole thickness of the soft tissues is destroyed by the ulcerative process, the area of bone which comes to form the base of the ulcer projects as a flat, porous node. In course of time the ulcer eats its way into the bone, and produces depressions or erosions on its surface. These changes have often been mistaken for disease originating in the bone.

The *irritable condition* is met with in ulcers which occur, as a rule, just above the external malleolus in women of neurotic temperament. They are small in size and have prominent granulations, and by the aid of a probe points of excessive tenderness may be discovered. These, Hilton believed, correspond to exposed nerve filaments.

*Ulcers which are spreading* may be met with in one of several conditions.

*The Inflamed Condition.*—Any ulcer may become acutely inflamed from the access of fresh organisms, aided by mechanical irritation from trauma, ill-fitting splints or bandages, or want of rest, or from chemical irritants such as strong antiseptics. The best clinical example of an inflamed ulcer is the venereal soft sore. The base of the ulcer becomes red and angry-looking, the granulations disappear, and a copious discharge of thin, yellow pus, mixed with blood, escapes. Sloughs of granulation tissue or of connective tissue may form. The edges become red, ragged, and everted, and the ulcer increases in size by spreading into the inflamed and œdematous surrounding tissues. Such ulcers are frequently multiple. Pain is a constant symptom, and is often severe, and there is usually some constitutional disturbance.

The *phagedænic condition* is the result of an ulcer being infected with specially virulent bacteria. It often occurs in syphilitic ulcers, and leads to a very rapid and destructive infiltration of the surrounding tissues, with the formation of sloughs and much pus. It is also met with in the throat in some cases of scarlet fever, and may give rise to fatal hæmorrhage by ulcerating into large blood-vessels. All the signs of inflammation, both local and constitutional, are present to a marked degree.

**Treatment of Ulcers.**—The prompt and patient treatment of ulcers is a matter of great practical importance. An ulcer is not only an immediate cause of suffering to the patient, crippling and incapacitating him for his work, but is a distinct and constant menace to his health: the prolonged discharge reduces his strength; the open sore is a possible source of infection by the

organisms of suppuration, erysipelas, or other specific diseases; phlebitis, with formation of septic emboli, leading to pyæmia, is liable to occur; and in old persons it is not uncommon for ulcers of long standing to become the seat of cancer. In addition, the offensive odour of many ulcers renders the patient a source of annoyance and discomfort to others.

**Principles of Treatment applicable to all Ulcers.**—The primary object of treatment in any ulcer is to bring it into the condition of a healing sore. When this has been effected nature will do the rest, provided extraneous sources of irritation are excluded.

Rest is an essential condition to the repair of all ulcers, and is best secured by confining the patient to bed. Elevation of the part to facilitate the venous return is also most important. The limb should be placed on pillows, or the foot of the bed raised upon blocks, so that the ulcer lies at a higher level than the heart. These measures at the same time encourage the absorption of inflammatory exudation around the ulcer, and this may be aided by *massage*. In certain varieties of ulcers associated with altered trophic innervation, nerve-stretching has been employed with advantage.

The use of elastic pressure or of strapping also accelerates the removal of exudation around ulcers, and so facilitates the contraction of the sore.

The removal of all sources of irritation, such as unsuitable dressings, ill-fitting splints, irritating applications, and, above all, septic organisms and their products, is imperative.

A septic ulcer must be thoroughly disinfected by washing not only the open surface, but also the skin for some distance around it, with an antiseptic lotion, such, for example, as lysol (1 in 100), to remove grease, and then with Lister's strong solution or carbolic lotion (1 in 20). Hair-covered parts should be shaved. The raw surface should then be swabbed over with undiluted carbolic acid or sprayed with peroxide of hydrogen. If the granulations are œdematous and unhealthy, they may be removed with a sharp spoon. An antiseptic dressing is then applied, and changed daily till the wound assumes a healthy appearance.

As the patient's health is below par, good nourishing food, tonics, and general hygienic treatment are indicated.

By paying attention to these general rules, and by employing certain special measures in different varieties of ulcers, the conditions of a healing sore will be obtained.

*Management of a Healing Sore.*—Perhaps the best dressing

for a healing sore is a layer of Lister's perforated oiled-silk protective, which is made to cover the raw surface and the skin for about a quarter of an inch beyond the margins of the sore. Over this three or four thicknesses of sterilised gauze, wrung out of boracic lotion or sterilised water, are applied, and covered by a pad of antiseptic absorbent wool. A splint is applied to ensure rest, and the part is elevated to avoid congestion.

The dressing may be renewed every two or three days, and care must be taken to avoid any rough handling of the sore. Any discharge which lies on the surface should be removed by a gentle stream of lotion rather than by wiping. The area around the sore should be carefully cleansed before the fresh dressing is applied.

In some cases healing goes on more rapidly under a dressing of weak boracic ointment (one-quarter the strength of the pharmacopœial preparation).

Dusting powders and poultice dressings are best avoided in the treatment of healing sores.

**Treatment of Special Varieties of Ulcers.**—Before beginning to treat a given ulcer two questions have to be answered—first, What are the causal conditions present? and second, In what condition do I find the ulcer?—in other words, In what particulars does it differ from a healthy healing sore?

If the cause is a local one, it must be removed; if a constitutional one, means must be taken to counteract it. This done, the condition of the ulcer must be so modified as to bring it into the state of a healing sore, after which it will be managed on the lines already laid down.

**Treatment in relation to the Cause of the Ulcer.**—*Traumatic Group.*—The *prophylaxis* of these ulcers consists in rigidly excluding bacteria, by cleansing crushed or bruised parts, and applying sterilised dressings and properly adjusted splints. These measures will often prevent a grossly injured portion of skin dying, and will ensure its asepticity should it do so. In the event of the skin giving way, the same form of dressing should be continued till the slough has separated and a healthy granulating surface is formed. The protective dressing appropriate to a healing sore is then substituted. *Pressure sores* are treated on the same lines.

The treatment of *burns and scalds* will be described later.

In the case of *ulcers due to interference with the venous return*, the primary indication is to elevate the limb to facilitate the free flow of the blood in the veins. Should varicose veins be present, the question of operative treatment must be considered.

When an *imperfect nerve-supply* is the main factor underlying ulcer formation, prophylaxis is the chief consideration. In patients suffering from spinal injuries or diseases, cerebral paralysis, or affections of the peripheral nerves, all sources of irritation, such as ill-fitting splints, tight bandages, moist applications, and hot bottles, should be avoided. Any part liable to pressure, from the position of the patient or otherwise, must be carefully protected by pads of wool, air-cushions, or water-bags, and must be kept absolutely dry. The skin should be hardened by daily applications of methylated spirit.

Should an ulcer form in spite of these precautions, the mildest and least irritant antiseptics must be employed for bathing and dressing it, and as far as possible all dressings should be dry.

The *perforating ulcer* of the foot calls for special treatment. To avoid pressure on the sole of the foot, the patient must be confined to bed. As the main local obstacle to healing is the down-growth of epithelium along the sides of the ulcer, this must be removed by the knife or sharp spoon. The base also should be excised, and any bone which may have become involved should be gouged away so as to leave a healthy and vascular surface. The cavity thus formed is stuffed with iodoform gauze and encouraged to heal from the bottom. After the ulcer is healed, the patient should wear in his boot a thick felt sole with a hole cut out opposite the situation of the cicatrix. When a joint has been opened into, the difficulty of thoroughly getting rid of all unhealthy and infected granulations is so great that amputation may be advisable; but it is to be remembered that the ulcer sometimes recurs in the stump when pressure is put upon it.

Exposure of the plantar nerves by an incision behind the internal malleolus, and subjecting them to forcible stretching, has been employed by Chipault and others in the treatment of perforating ulcers of the foot.

The treatment of any nervous disease or glycosuria which may coexist is, of course, indicated. The ulcer which forms in relation to callosities on the sole of the foot is treated by paring away all the thickened skin after softening it with soda fomentations, removing the unhealthy granulations, and applying stimulating dressings.

*Treatment of Ulcers due to Constitutional Causes.*—When ulcers are associated with such constitutional diseases as diabetes, Bright's disease, scurvy, or gout, these must be treated on general principles.

Tuberculous and syphilitic patients also must receive the appropriate medicinal and dietetic treatment for their general conditions.

The *tuberculous ulcer* calls for special local treatment. By means of knife, scissors, or sharp spoon, all foci of tuberculous disease, whether in the skin or in the deeper parts, must be freely removed, so as to leave a healthy surface from which granulations may spring up. Should the raw surface left be extensive and likely to result in an unsightly scar, much benefit may result from skin-grafting.

In some cases the area involved is so extensive that the surgeon may hesitate to excise it bodily. The alternative is to clip or scrape away all grossly diseased tissue and granulations, to slit up all sinuses, and then to purify everything with undiluted carbolic acid. Iodoform is held in high esteem as an agent which counteracts the tubercle bacillus and its products. In many cases marked benefit has followed the application of the X-rays.

The healing of such sores is often slow and tedious, and experience shows that frequent changes in the dressings employed are often beneficial.

*The Syphilitic Ulcer.*—No ulcerative process responds so readily to medicinal treatment as the syphilitic ulcer does to full doses of iodide of potassium and mercury, and the local application of black wash. When the ulceration has lasted for a long time, however, and is widespread and deep, the duration of treatment is materially shortened by a thorough scraping with the sharp spoon.

**Treatment in relation to the Condition of the Ulcer.**—*Ulcers in a Weak Condition.*—If the weak condition of the ulcer is due to anæmia or kidney disease, these affections must first be treated. Locally, the imperfect granulations should be scraped away, and some stimulating agent, such as red lotion (2 grains of sulphate of zinc, and 10 minims of compound tincture of lavender, to an ounce of water), applied to the raw surface till healthy granulations form.

When the condition has resulted from the prolonged use of moist dressings, these must be stopped, the redundant granulations clipped away with scissors, the surface rubbed with silver nitrate or sulphate of copper (blue-stone), and dry dressings applied.

When the ulcer has assumed the characters of a healing sore, Thiersch grafts may be applied to hasten cicatrisation.

*Ulcers in a callous condition* call for treatment in three

directions—(1) The venous return must be facilitated by elevation of the limb and massage. (2) The induration of the surrounding parts must be got rid of before contraction of the sore is possible. For this purpose the free application of blisters, as first recommended by Syme, leaves little to be desired. Liquor epispasticus painted over the parts, or a large fly-blister (emplastrum cantharidis) applied all round the ulcer, speedily disperses the inflammatory products which cause the induration. Multiple incisions in the skin around the ulcer fulfil the same object more rapidly and efficiently, and are therefore to be preferred. (3) The septic element in the ulcer must be eliminated. When the ulcer is very foul, relays of charcoal poultices (three parts of linseed meal to one of charcoal), maintained for thirty-six to forty-eight hours, are useful as a preliminary step. The base of the ulcer and the thickened edges should then be freely scraped with a sharp spoon, and the resulting raw surface sponged over with undiluted carbolic acid, after which an antiseptic dressing is applied, and changed daily till healthy granulations appear. When these are slow to form, the sore may be stimulated by a dressing of boracic lint wrung out of red lotion and covered with a layer of gutta-percha tissue.

So soon as the ulcer assumes the characters of a healing sore, it should be covered with Thiersch skin-grafts, which form a much better cicatrix than when the ulcer is allowed to heal without such aid.

A more radical and very successful method of treatment consists in excising the whole ulcer and grafting the raw surface.

*Ambulatory Treatment.* — When the circumstances of the patient forbid his lying up in bed the healing of the ulcer will be much delayed. He should be instructed to take every possible opportunity of placing the limb in an elevated position; and must constantly wear a firm bandage of *elastic webbing*. This webbing is porous and admits of evaporation of the skin and wound secretions—an advantage it has over Martin's rubber bandage. The bandage should extend from the toes to well above the knee, and should always be applied while the patient is in the recumbent position with the leg elevated, preferably before getting out of bed in the morning. Additional support is given to the veins if the bandage is applied as a figure-of-eight, after the method suggested by Heron-Watson.

We have found the following method very satisfactory in out-patient practice. The patient lying on a couch, the limb is

raised about eighteen inches and kept in this position for five minutes—till the excess of blood has left it. With the limb still raised, the ulcer with the surrounding skin is covered with a layer, about half an inch thick, of finely powdered boracic acid, and the leg, from knee to foot, excluding the sole, is enveloped in a thick layer of wood-wool wadding. This is held in position by ordinary cotton bandages, painted over with liquid starch. While the starch is drying the limb is kept elevated. With this appliance the patient may continue to work, and the dressing does not require to be changed oftener than once in three or four weeks (W. G. Richardson).

*Unna's bandage*—a bandage stiffened with gelatin—is useful, but somewhat inconvenient for the class of patients who usually suffer from this condition.

An *inflamed* ulcer is treated by rest, elevation, and the application of moist antiseptic and soothing dressings. Ichthyol ointment spread on gauze and applied to the surrounding parts is very soothing.

The *phagedænic* ulcer is simply an aggravated form of the inflamed variety produced by some virulent organism or poison, and calls for more energetic treatment to arrest its spread, which is often rapid and destructive. The whole of the affected surface may be touched with the actual cautery at a white heat, or the surface may be painted with pure carbolic acid and a dressing of iodoform gauze applied.

The *irritable* state of an ulcer may depend upon constitutional neurotic tendencies, uterine irregularities, or upon a gouty diathesis, and in treatment these must be counteracted. Locally the most satisfactory treatment is complete excision and subsequent skin-grafting. Short of this, the use of the sharp spoon, silver nitrate, or pure carbolic acid may be tried.

### Skin-Grafting.

The term skin-grafting is applied to certain procedures in which portions of epithelium or skin are applied to raw or granulating surfaces with a view to promoting the rapid formation of a cicatrix which is at once strong and pliable, and which does not subsequently tend to undergo contraction.

The grafts may be taken from the patient himself,—on the whole the most satisfactory source,—from another person, or from one of the lower animals.

The procedure is applicable to all forms of ulcers when in a

healthy, healing condition, especially those resulting from burns, severe crushes, or septic processes involving wide destruction of skin. It may also be employed to cover in the raw surfaces left after the excision of new growths implicating the skin, or of patches of lupus. In rectifying such defects as extroversion of the bladder, ectropion of the eyelids, destruction of the cheek or nose, and in other plastic operations also, skin-grafting is often of value.

It is of primary importance that the surface on which the grafts are placed should be aseptic and have a good vascular supply. The surrounding tissues also must be free of inflammation, œdema, or induration.

The best results are obtained when the grafts are placed on a fresh raw surface. A granulating surface is, on the whole, less satisfactory, because of the difficulty of ensuring its asepticity, and on account of the tendency of a cicatrix formed by granulation tissue to undergo contraction.

*Preparation of the Surface.*—For two or three days the ulcer and its surroundings should be thoroughly purified, and it is often advantageous to paint the surface with pure carbolic acid daily during this period.

In old-standing ulcers of the leg it is best to excise the whole ulcer, including its edges and about a quarter to half an inch of the surrounding tissue, as well as the underlying fibrous tissue. In extensive ulcers resulting from recent burns, if the granulations are healthy and aseptic, the grafts may safely be placed on them directly. If, however, their asepticity cannot be relied upon it is necessary to scrape away the superficial layer of the granulations, the young fibrous tissue underneath being conserved, as it is sufficiently vascular to nourish the grafts placed over it. There is no advantage in preserving any young epithelium which may have formed round the ulcer, as this is very liable to break down after the grafts have united, leaving a raw ring round the newly formed cicatrix. Oozing can be stopped by pads of sterilised gauze saturated with peroxide of hydrogen (10 volumes strength), and after the bleeding has ceased the excess of peroxide solution is washed away by a copious yet gentle stream of saline solution. In some cases pressure with a pad of sterilised gauze is sufficient to arrest the oozing, a layer of protective having been placed next the wound to prevent the gauze adhering and starting the bleeding afresh when the gauze is removed.

The part from which the grafts are taken should be disinfected as for any other operation.

**Methods of Grafting.**—Several different procedures, which involve the transplantation of tangible portions of epithelium, are included under the term *epithelium-grafting*. Of these the methods of Reverdin and Thiersch are the most useful.

In *Reverdin's* method a portion of the patient's skin is raised with the point of a needle, and a piece about the size of a split pea removed with a razor or a pair of scissors curved on the flat. The graft, which consists of the epidermis and the superficial layers of the rete mucosum, is then cut into fragments not bigger than a pin-head, and these are planted over the surface. As each of these fragments has only a potential growth of about half an inch in diameter, it is advisable to place them so that the edges of the adjacent epithelial islets which form will touch one another, and to plant them near the edge of the ulcer, in order that the grafted epithelium may blend with that of the margin and so consolidate the cicatrix. Unless this is done granulations grow up between the islets and often destroy them. The prepuce removed from a healthy child by circumcision may be used for Reverdin grafting.

The dressing consists of imbricated pieces of oiled-silk protective covered with pads of aseptic gauze and absorbent wool, the part being immobilised by a suitable splint. The dressing is changed in four or five days. Many of the grafts disappear temporarily, but reappear in the course of a few days as thin bluish-white patches which gradually increase in size and thickness. Great care is necessary to prevent the cicatrix from breaking down again. The application of lanoline or weak boracic ointment (a quarter the pharmacopœial strength) prevents the young epithelium from cracking, and keeps it soft and pliable.

*Thiersch's Method.*—For all practical purposes this is the procedure which yields the most satisfactory results and which is most generally applicable. It consists in transplanting strips of epidermis, shaved from the surface of the skin, the razor passing through the tips of the papillæ. The grafts are most conveniently obtained from the inner aspect of the thigh or upper arm, or from the front of the forearm, the skin in these regions being soft, pliable, and comparatively free from hairs. They are cut with a sharp hollow-ground razor, or Thiersch's skin-grafting knife, the blade of which is moistened with warm saline solution. The skin is stretched and kept flat and perfectly steady. To ensure uniform strips being cut the razor must be kept parallel with the surface, and used with a short, rapid sawing movement. With a little practice grafts

six or eight inches long by one or two inches broad can readily be cut.

The strips of epithelium thus obtained are directly transferred to the surface prepared for them, for which they should be made to form a complete carpet, slightly overlapping the edges of the sore and of one another.

Firm pressure is then made with a pad of gauze over the grafts to express blood and air-bubbles, and to ensure accurate apposition. Some difference of opinion exists regarding the best dressing. It would appear that when the grafts are applied to a fresh raw surface, and when there is no reason to anticipate any discharge, a dry, aseptic gauze dressing is most appropriate, or the same gauze smeared with sterilised vaseline. When the grafts are applied to a granulating surface, however, and when there may be doubt as to its perfect asepticity, perforated protective should be applied.

When it is feasible—for example, on the face or limbs of adults who will remain still during the after-treatment—we have found that it is best not to apply any dressing over the grafts, which are left freely exposed and only protected by a wire cage or shield such as is used after vaccination.

The surface from which the grafts have been taken is covered with a dry gauze dressing, or with a dressing of picric acid such as is used for superficial burns.

It is often difficult to decide when the dressing should be changed. In cases where a dry dressing has been employed it may be left in position for from seven to ten days, by which time the grafts have united. It may then be replaced by a dressing of weak boracic ointment or lanoline. When a protective dressing is used it must be changed every third or fourth day until the grafts become fixed, after which an ointment dressing is substituted. In all cases the utmost gentleness and care are necessary to avoid disturbance of the adhesions between the grafts and the ulcer. After grafting leg ulcers, prolonged rest in the recumbent position is imperative, to obviate the tendency of the cicatrix to break down when the limb is allowed to hang. The limb should not be used for walking within two or three months of being grafted.

The new skin is at first insensitive and is fixed to the underlying tissue, but in course of time new nerve fibres grow into it and sensation is restored, and the development of elastic tissue in the deeper part of the cicatrix renders it pliable and movable.

*Skin-grafting* proper consists in transplanting portions of

the whole thickness of the true skin, excluding the subcutaneous fat (Wolfe-Krause). When the grafts are taken from the human subject they should be cut oval or spindle shaped, to facilitate the stitching of the edges of the resulting wound. It is to be borne in mind that when separated from the body these portions of skin contract to about two-thirds of their original size, and this shrinkage must be allowed for when it is desired to cover a raw surface with a single graft. These grafts may be placed either on a fresh raw surface or on healthy granulations (Young). It is sometimes an advantage to stitch them in position, especially on the face. The primary dressing and the subsequent treatment are the same as in Thiersch grafting. When successful this method yields most satisfactory results.

*Skin-grafting from the Lower Animals.* — The best results have been obtained by planting the whole thickness of the skin of young warm-blooded animals, such as puppies, kittens, or rabbits, on a fresh raw surface. The animal is killed with chloroform, the anterior abdominal wall and flanks are shaved, and the skin, after being dissected up free of fat, is cut into pieces about two inches by one, and placed on the surface to be covered in. The after-treatment is the same as in Thiersch grafting. The hairs and skin glands are not reproduced.

*Grafting of Mucous Membrane.*—Successful attempts have been made to cover over defects in various mucous membranes, such as the conjunctiva, the cheek, and the urethra, by grafts of mucous membrane taken from man or from the lower animals. The technique is similar to that employed in skin-grafting.

# CHAPTER VII.

## GANGRENE.

Definition—Clinical types: *Dry, Moist*—Clinical varieties—Gangrene primarily due to interference with the circulation: *Physico-chemical group; Embolic gangrene; Gangrene following ligation of arteries; Senile gangrene, atheroma; Diabetic gangrene; Gangrene from angio-sclerosis; Gangrene from ergot; Raynaud's disease; Gangrene after acute fevers*—Gangrene primarily due to bacterial infection: *Acute traumatic gangrene; Malignant œdema; Cancrum oris; Phagedæna*—Bed-sores.

The term gangrene is used to indicate the process by which a portion of tissue dies *en masse*, as distinguished from the molecular or cellular death which constitutes ulceration. The dead portion is known as a *slough*.

Gangrene may occur in any tissue of the body, and portions of limbs, of intestine, of lung, penis, or even of brain tissue, may die *en masse* and be thrown off as sloughs.

In this chapter we shall confine our attention to the process as it affects the limbs and superficial parts of the body, leaving gangrene of the viscera to be described in regional surgery.

### Clinical Types of Gangrene.

Two distinct types of gangrene are met with clinically, which, from their most obvious point of difference, are known as *dry* and *moist gangrene* respectively.

We shall have to study each of these types in detail; but, speaking generally, it may be said that dry gangrene is essentially due to a simple *interference with the blood-supply* of a part; while an essential factor in the production of moist gangrene is *bacterial infection*.

Several clinical varieties of each type are met with, but before describing these we shall first study the fundamental distinctions between the two types.

**Dry Gangrene or Mummification** is a comparatively slow

form of local death resulting, as a rule, from a diminution in the arterial blood-supply of the affected parts, due to such causes as the sudden blocking of the main vessel of supply by a thrombus, or the gradual diminution of the lumen of the arteries by atheroma. The fluids in the tissues are lost by evaporation, and the part becomes dry and shrivelled.

As the skin is usually intact, bacterial infection does not take place, or if it does, the want of moisture in the part renders it an unsuitable soil, and the organisms do not readily find a footing. Thus the effects of sepsis are absent, and any spread of the process which may take place is influenced by the anatomical distribution of the blocked arteries, and is arrested as soon as it reaches an area rich in anastomotic vessels. The throwing off of the dead portion is brought about by the formation of what is known as a *line of demarcation*. The irritation resulting from the contact of the dead with the still living tissue causes hyperæmia with dilatation of the blood-vessels, and infiltration with leucocytes on the proximal side of the junction. Granulations soon sprout from the living tissue, and by slowly eating into the dead portion produce a furrow, which gradually deepens until the complete separation of the slough is effected. Owing to the way in which the blood-vessels are distributed, the death of skin and subcutaneous tissues extends higher than that of muscles and bone, with the result that the stump left after spontaneous separation is conical, the end of the bone projecting beyond the soft parts.

*Clinical Features.* — The part undergoing mortification becomes colder than normal, the temperature falling to that of the surrounding atmosphere. In many instances, but not in all, the onset of the process is accompanied by severe neuralgic pains in the part, probably due to anæmia of the nerves, to neuritis, or to the irritation of the exposed axis cylinders by the dead and dying tissues around them. This pain soon ceases and gives place to a complete loss of sensation. The dead part becomes dry, horny, shrivelled, and semi-transparent—at first of a dark-brown, but finally of a black colour, from the dissemination of blood pigment throughout the tissues. There is no putrefaction, and therefore no disagreeable odour; and the condition being non-infective, there is not necessarily any constitutional disturbance. In itself, therefore, a loss of tissue by the process of dry gangrene does not involve immediate risk to the life of the patient. The danger lies in the fact that the raw surface at the line of demarcation furnishes a possible means of entrance for bacteria, which may lead to septic complications.

**Moist Gangrene** is an acute process, the dead part retaining its fluids, and so affording a favourable soil for the development of putrefactive or pyogenic bacteria. The action of the organisms, their toxins, and the inflammatory exudates on the adjacent tissues, leads to a rapid and wide spread of the process. The formation of a sulphide of iron by decomposition of the blood pigment gives to the tissues a greenish-black colour. The putrefactive gases evolved cause the tissues to become emphysematous and crepitant. The skin becomes moist and macerated, and bullæ, containing dark-coloured fluid or gases, form under the epidermis. There is always an offensive putrid odour. Under certain conditions the dead part may undergo changes resembling more closely those of ordinary post-mortem decomposition. Owing to its nature the process seldom spontaneously arrests itself, but usually continues to spread, and proves fatal from the absorption of toxins into the circulation.

The *clinical features* vary in the different varieties of moist gangrene, but in all we have the local results of bacterial action more or less marked; and the usual constitutional disturbances associated with septic intoxication are present. The prognosis in moist gangrene is always grave in the extreme.

From what has been said it will be gathered that in dry gangrene there is no urgent call for operation to save the patient's life, the primary indication being to prevent the access of bacteria to the dead part, and especially to the raw surface exposed in the line of demarcation. In moist gangrene, on the contrary, the organisms having already obtained a footing, immediate removal of the dead and dying tissues, as a rule, offers the only hope of saving life.

## Clinical Varieties of Gangrene.

As has already been pointed out, the factor which plays the most important *rôle* in determining whether a given case of gangrene belongs to the moist or the dry type is the presence or absence of *bacterial infection.*

The different forms which gangrene assumes clinically are so varied that it is difficult to devise a simple classification. For practical purposes, however, they may be divided into two great classes: I. Those in which the gangrene is essentially due to *interference with the circulation*; and II. Those in which it is essentially due to *bacterial infection.*

**Gangrene essentially due to Interference with the Circulation.**—This group includes the various forms of local

tissue necrosis in which micro-organisms do not play the most important part in producing death. Their subsequent introduction is an accident, albeit one of such importance that it changes the whole aspect of affairs and converts a dry form of gangrene into one of the moist type. Moreover, the low state of vitality of the tissues, and the extreme difficulty of securing and maintaining asepsis, make it a sequel of great frequency.

*Gangrene from Physico-chemical Causes.*—When a localised portion of tissue—for example, a piece of skin—is so severely crushed or bruised that its blood-vessels are occluded and its structure destroyed, it immediately dies, and, if not infected with bacteria, dries up and forms a shrivelled brown slough, which is slowly separated by the growth of granulation tissue beneath and around it (Fig. 21).



Fig. 21.—Dry Gangrene of Skin after Amputation at Shoulder-joint for Railway Injury.

Fingers, toes, or even considerable portions of limbs may in the same way be suddenly destroyed by severe trauma and undergo mummification. If organisms gain access, typical moist gangrene may ensue, or changes similar to those of ordinary post-mortem decomposition may take place.

Severe *burns* and *scalds* may be followed by the same results. So long as the parts are kept absolutely dry—as, for example, by the picric acid method of treatment—the grossly damaged portions of tissue undergo dry gangrene; but when moist or oily dressings are applied and organisms gain access, moist gangrene follows.

*Gangrene from Frost-bite.*—It is difficult to draw the line between the third degree of chilblain and the milder forms of true frost-bite. The difference is merely one of degree. Frost-bite affects chiefly the toes and fingers,—especially the great toe and the little finger,—the ears, and the nose. In this country it is seldom seen except in members of the tramp class, who, in addition to being exposed to cold by sleeping in the open air, are ill-fed and generally debilitated. The condition usually manifests itself after the parts, having been subjected to extreme cold, are brought into warm surroundings. The first symptom

of frost-bite is numbness in the part. This is followed by a sense of weight, tingling, and finally by complete loss of sensation. The part attacked becomes white and bleached-looking, feels icy cold, and is insensitive to touch. The limb above the dead area may be the seat of excruciating pain. Either immediately, or, it may be, not for several days, it becomes discoloured and swollen, and finally contracts and shrivels. The dead portion is cast off, as in other forms of dry gangrene, by the formation of a line of demarcation.

*Prophylaxis.*—The first essential in the prophylaxis of gangrene from frost-bite is to avoid the too sudden application of heat. The patient should be placed in a cold room, and the part rubbed with snow or put in a cold bath, and have light friction applied to it. As the circulation is restored the general surroundings and the local applications are gradually made warmer. Elevation of the part, wrapping it in cotton wool, and removal to a warmer room are then permissible, and stimulants and warm drinks may be given with caution. When by these means the onset of gangrene is averted, recovery ensues, its onset being indicated by the white parts assuming a livid red hue and becoming the seat of an acute burning sensation.

Strong *chemical agents*, such as caustic potash, nitric or sulphuric acid, may also induce local tissue necrosis, the general appearances of the lesions produced being very like those of severe burns. The resulting sloughs are very slow to separate, and leave deep punched-out cavities which are long of healing.

*Carbolic acid*, even in comparatively weak solution, is liable to induce dry gangrene when applied as a fomentation to a finger, especially in women and children (Fig. 22). Thrombi form in the blood-vessels of the part, which at first is pale and soft, but later becomes dark and leathery. On account of the anæsthetic action of carbolic acid the onset of the process is painless, and the patient does not realise his danger. A line of demarcation soon forms, but the dead part separates very slowly.

*Gangrene from Mechanical Constriction of the Vessels of the part.*—The application of a bandage or plaster of Paris case too tightly, or of a tourniquet for too long a time, has been known to lead to death of the part beyond ; but such cases are rare, as are also those due to the pressure of a fractured bone or of a tumour on a large artery or vein. When gangrene occurs from such causes it tends to be of the moist type. Much commoner is it to meet with localised areas of sloughing due to the excessive pressure of splints over bony prominences, such as the external

malleolus, the internal condyle of the humerus or femur, or over the dorsum of the foot. This is especially liable to occur when the nutrition of the skin is depressed by any interference with its nerve-supply, such as follows injuries to the spine or peripheral nerves, diseases of the brain, or infantile paralysis. On removing the splint the part pressed upon is found to be of a pale yellow or grey colour, and is surrounded by a ring of hyperæmic or congested skin. If purified and protected from septic infection the clinical course is that of typical dry gangrene.

Closely allied to this is the *bed-sore* in which sloughs of the



Fig. 22.—Carbolic Gangrene. Girl æt. 22. Carbolic compress (1 in 60) applied overnight. Finger gangrenous in the morning.

skin and soft parts often form. Bed-sores will be described at the end of this chapter.

*Treatment.*—The first indication in the treatment of the above varieties of gangrene is the exclusion of bacteria by thorough purification of the damaged tissue and its surroundings, and the application of dry, non-irritating antiseptic dressings.

When these measures are successful dry gangrene ensues. The raw surface left after the separation of a slough of the skin may be allowed to heal by granulation, or may be covered by Thiersch skin-grafts. In the case of fingers or limbs it is not necessary to wait until spontaneous separation takes place, as this is often a very slow and tedious process. When a well-marked line of demarcation has formed, amputation may be performed just sufficiently far above it to enable suitable flaps to be made.

The ends of stumps left after spontaneous separation of the gangrenous portion require to be trimmed, sufficient bone being removed to permit of the soft parts coming together.

If moist gangrene supervenes, amputation must be performed at a higher level without delay.

**Embolic Gangrene.**—When the main artery of a part is *suddenly* occluded, whether by the impaction of an embolus or the formation of a thrombus in its lumen, unless the collateral circulation is sufficiently free to maintain the vitality of the tissues, gangrene results.

There is sudden pain at the site of impaction of the embolus, and the pulses beyond are lost. The limb becomes cold, numb, insensitive, and powerless. It is often pale at first—hence the term "white gangrene" sometimes applied to the early appearances, which closely resemble those presented by the limb of a corpse.

If the part is aseptic it becomes shrivelled, and presents the ordinary features of dry gangrene. It is very liable, however, especially in the lower extremity and where the veins also are obstructed, to become infected and to assume the characters of the moist type.

The *abdominal aorta* may become suddenly occluded by an embolus, the obstruction extending into the iliacs and femorals, and inducing symmetrical gangrene of both extremities as high as Poupart's ligament. When gangrene follows occlusion of the *external iliac*, or of the *common femoral artery*, the death of the limb extends as high as the middle or upper third of the thigh. When the *superficial femoral or popliteal artery* is obstructed, the veins remaining pervious, the anastomosis through the profunda is sufficient to maintain the vascular supply, and gangrene does not necessarily follow. The rupture of a popliteal aneurysm, however, by compressing the vein and the articular vessels, usually determines gangrene. When an embolus becomes impacted at the *bifurcation of the popliteal* the gangrene which ensues usually spreads well up the leg.

When the *axillary artery* is the seat of embolic impaction and gangrene ensues, the process usually reaches the middle of the upper arm. Gangrene following blocking of the *brachial* at its bifurcation usually extends as far as the lower third of the forearm.

*Treatment.*—The general treatment of embolic gangrene is the same as that for the senile form, which will be described in the next section When amputation is indicated it must be performed sufficiently high to ensure a free vascular supply to the flaps.

**Gangrene following Ligation of Arteries.**—After the ligation of an artery in its continuity—for example, in the treatment of aneurysm—the limb may for some days remain in a condition verging on gangrene, the distal parts being cold, devoid of sensation, and powerless. As the collateral circulation is established, the vitality of the tissues is gradually restored and these symptoms pass off. In some cases, however—and especially in the lower extremity—gangrene ensues and presents the same characters as that resulting from embolism. It tends to be of the dry type. The risk of gangrene is generally believed to be increased if the vein be occluded as well as the artery. In the light of some cases we have observed, in which both vessels were ligatured without gangrene supervening, we are inclined to believe that undue importance has been attached to this factor.

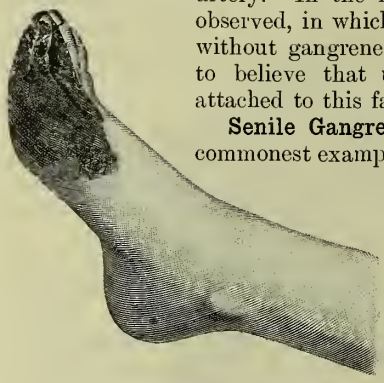


Fig. 23.—Senile Gangrene in a man, æt. 48, whose Arteries were extremely atheromatous.

**Senile Gangrene.**—Senile gangrene is the commonest example of local death produced by a *gradual* diminution in the quantity of arterial blood passing through the parts, as a result of atheroma or other chronic disease of the vessels leading to diminution of their calibre. It is the most typical example of the dry type of gangrene. As the term indicates, it occurs in old persons; but the patient's age is to be reckoned by the condition of his arteries rather than by the number of his years (Fig. 23). Thus the vessels of a comparatively young man who has suffered from syphilis and been addicted to alcohol, are more liable to atheromatous degeneration leading to this form of gangrene than are those of a much older man who has lived a regular and abstemious life. This form of gangrene is much more common in men than in women. While it usually attacks only one foot, it is not uncommon for the other foot to be affected after an interval, and in some cases it is bilateral from the outset. It must clearly be understood that any form of gangrene may occur in old persons, the term senile being here restricted to that variety which results from atheroma.

*Clinical Features.*—The commonest seat of the disease is in

the toes, especially the great toe, whence it spreads up the foot to the heel, or even to the leg. Although not necessarily traumatic in origin, there is often a history of some slight injury preceding its onset. The vitality of the tissues is so low that the balance between life and death may be turned by the most trivial injury, such as a cut while paring a toe-nail or a corn, a blister caused by an ill-fitting shoe or the contact of a hot-bottle. In some cases the actual gangrene is determined by thrombosis of the popliteal or tibial arteries, which are already narrowed by atheroma.

It is common to find that the patient has complained of extraordinarily cold feet, with tingling and loss of feeling, or a peculiar sensation as if walking on cotton wool, for a long time before the onset of definite signs of gangrene.

The first evidence of the death of the part varies in different cases. Sometimes a dark-blue spot appears on the inner side of the great toe and gradually increases in size; or a blister containing blood-stained fluid may form. In other cases a small sore surrounded by a congested areola forms in relation to the nail and refuses to heal. Such "sore-toes" in old persons are always to be looked upon with suspicion and treated with the greatest care. There is often severe, deep-seated pain of a neuralgic character, with cramps in the limb, and these may persist long after a line of demarcation has formed, or even after the slough has separated. The dying part loses sensibility to touch and becomes cold and shrivelled.

All the physical appearances and clinical symptoms associated with dry gangrene supervene, and the dead portion is thrown off by the formation of a line of demarcation. This is a very slow process, and is always attended with the risk of septic infection taking place. Should this occur, the temperature rises and other evidences of septic absorption appear.

*Prophylaxis.*—The toes and feet of old people, the condition of whose circulation predisposes them to gangrene, should be specially protected from slight injuries such as may be received while paring nails, cutting corns, or wearing ill-fitting boots. The patient should also be warned of the risk of exposure to cold, the use of hot-bottles, and of placing the feet near a strong fire.

*Treatment.*—When there is evidence that gangrene has begun, the first indication is to prevent septic infection by thoroughly purifying the part with an efficient antiseptic, and after careful drying to wrap it in a thick layer of absorbent and antiseptic wool, retained in place by a loosely applied bandage. A slight

degree of elevation of the limb is an advantage, but it must not be sufficient to diminish the amount of blood entering the part. Hot-bottles are to be used with the utmost caution. As absolute dryness is essential, all ointments or other oily or greasy dressings are to be avoided, as they tend to prevent evaporation from the skin surface. Opium should be given freely to alleviate pain. Excessive stimulation is to be avoided, and the patient should be carefully dieted.

Some surgeons advocate the expectant method of treatment, waiting for a line of demarcation to form and allowing the dead part to be spontaneously separated. This takes place so slowly, however, that the majority prefer to amputate early.

In this connection it is worthy of note that there are certain points at which gangrene naturally tends to become arrested—

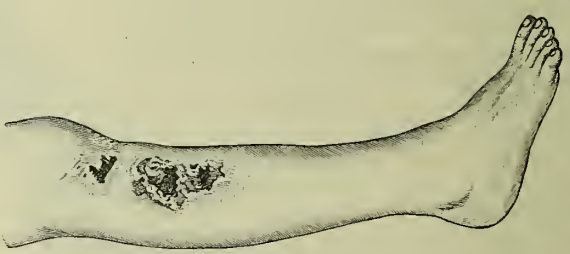


Fig. 24.—Diabetic Gangrene of Skin.

namely, at the highly vascular areas in the neighbourhood of joints. Thus gangrene of the great toe often stops when it reaches the metatarso-phalangeal joint; or if it trespass this limit it may be arrested either at the tarso-metatarsal or at the ankle joint. If these be passed it usually spreads up the leg to just below the knee before signs of arrestment appear. Further, it is seen from pathological specimens that the spread is greater on the dorsal than on the plantar aspect, and that the death of skin and subcutaneous tissues extends higher than that of bone and muscle.

These facts furnish us with valuable indications as to the seat and method of amputation. Experience has proved that in senile gangrene of the lower extremity reliable and satisfactory results are only to be obtained by amputating in the region of the knee, care being taken to perform the operation so as to leave the prepatellar anastomosis intact by retaining the patella in the anterior flap. The operation recommended is disarticulation at

the knee by means of a circular incision carried round the limb, about three inches below the tubercle of the tibia, the joint being fully extended (A. G. Miller). Gritti's supra-condylar amputation is also suitable. Hæmorrhage is easily controlled by digital pressure, and the use of a tourniquet should be dispensed with, as the constriction of the limb is liable to interfere with the vitality of the flaps.

When the tibial vessels can be felt pulsating at the ankle it may be justifiable, if the patient urgently desires it, to amputate lower than the knee; but in the great majority of cases gangrene recurs in the stump and necessitates a second operation.

That amputation for senile gangrene performed between the ankle and the knee seldom succeeds, is explained by the fact that the vascular obstruction is usually in the upper part of the posterior tibial artery, and the operation is therefore performed through tissues with an inadequate blood-supply. It is not uncommon, indeed, on amputating above the knee to find even the popliteal artery plugged by a clot. This should be removed by squeezing the vessel from above downward by a "milking" movement, or by "catheterising the artery" with the aid of a cannula with a terminal aperture.



FIG. 25. — Diabetic Gangrene. Glycosuria unsuspected till Gangrene developed.

It is to be borne in mind that the object in amputating in these cases is merely to remove the gangrenous part, and so to relieve the patient of the discomfort and the risks from sepsis which its presence involves. While it is true that in spite of the feeble condition of many of these patients, the operation is borne remarkably well, provided it is done early and before the patient is worn out by pain and want of sleep, a guarded opinion should be expressed as to the period during which the patient will survive the operation. The risk of the other limb subsequently becoming gangrenous has already been referred to.

**Diabetic Gangrene.**—This form of gangrene is specially prone to occur in patients over fifty years of age who suffer from diabetes mellitus. It is seldom associated with diabetes insipidus. In some cases the existence of the diabetes is unsuspected before the onset of the gangrene. The gangrenous

process seldom begins as suddenly as that associated with embolism, and like senile gangrene, which it may closely simulate in its early stages, it not infrequently begins after a slight injury to one of the toes. It but rarely, however, assumes the dry, shrivelling type, as a rule being attended with swelling, œdema and dusky redness of the foot, and severe pain. According to Sir James Paget, the dead part remains warm longer than in other forms of senile gangrene; there is a greater tendency for patches of skin at some distance from the primary seat of disease to become gangrenous (Figs. 24, 25); and for the death of tissue to extend upwards in the subcutaneous planes, leaving the overlying skin unaffected. The low vitality of the tissues favours the growth of bacteria, and, if these gain access, the gangrene assumes the characters of the moist type and spreads rapidly. There is usually a peculiarly offensive odour about the patient, which differs from that of other forms of moist gangrene. Unless treated by amputation, death usually occurs from coma, toxæmia, or exhaustion.

The rules for amputation are the same as those governing the treatment of senile gangrene, the level at which the limb is removed depending upon whether the gangrene is of the dry or moist type. The general treatment for diabetes must, of course, be employed whether amputation is performed or not. Paget recommends that the diatetic treatment should not be so rigid as in uncomplicated diabetes, and that opium should be given freely.

The *prognosis* even after amputation is usually unfavourable. In some cases the patient dies with symptoms of diabetic coma within a few days of the operation. In others there is sloughing of the flaps and death results from toxæmia. Occasionally the other limb becomes gangrenous. Even when the patient survives the operation there is considerable risk of the diabetes proving fatal.

A form of gangrene is occasionally met with in robust young persons, even in children, due to a marked degree of *angiosclerosis*, with narrowing and thrombosis of the main arteries as well as of the smaller veins. It usually occurs in the feet, is exceedingly painful, and runs a slow, tedious course; it generally calls for amputation.

*Gangrene from Ergot.*—Gangrene may occur from interference with blood-supply, the result of tetanic contraction of the minute vessels, such as results in ill-nourished persons who eat large quantities of coarse rye bread contaminated with the *claviceps purpurea* and containing the ergot of rye. The process, which

attacks the toes, fingers, ears, or nose, is preceded by formication, numbness, and pains in the parts to be affected. Following on this, dry gangrene supervenes, and may spread to a considerable extent.

In this country it is usually met with in sailors off foreign ships, whose dietary largely consists of rye bread. Trivial injuries may be the starting-point, the anæsthesia produced by the ergotin preventing the patient taking notice of them. Alcoholism is a potent predisposing cause.

As it is impossible to predict how far the process will spread, it is advisable to wait for the formation of a line of demarcation before operating on these cases, and then to amputate immediately above the disease.

*Raynaud's Disease*, or Symmetrical Gangrene, is supposed to be due to spasm of the arterioles, resulting from peripheral neuritis. It occurs oftenest in neurotic females, between the ages of eighteen and thirty, who are the subjects of uterine disorders, anæmia, or chlorosis. Cold may be a predisposing factor, as the disease is commonest during the winter months. The digits of both hands or the toes of both feet are simultaneously attacked, and the disease seldom spreads beyond the phalanges or deeper than the skin.

The first evidence is that the fingers become cold, white, insensitive to touch and pain. These attacks of *local syncope* recur at varying intervals for months or even years. They last for a few minutes or even for some hours, and as they pass off the parts become hyperæmic and painful.

A more advanced stage of the disease is known as *local asphyxia*. The circulation through the fingers becomes exceedingly sluggish, and the parts assume a dull livid hue. There is swelling and burning or shooting pain. This may pass off in a few days, or may increase in severity, with the formation of bullæ, and end in dry gangrene. As a rule the slough which forms is comparatively small and superficial, but it may take some months to separate. The condition tends to recur in successive winters.

The *treatment* consists in attending to the general condition of the patient, remedying any nervous or uterine disorder which may be present, and keeping the parts warm by wrapping them in cotton wool. When gangrene occurs it is treated on the same lines as other forms of dry gangrene, but if amputation is called for it is only with a view to removing the dead part.

*Gangrene occurring after Acute Fevers.*—A variety of dry gangrene is sometimes met with in patients recovering from

typhus, typhoid, or other fevers. It is due to endarteritis, thrombosis, or embolism, and occurs in peripheral parts, such as the toes, fingers, nose, or ears.

### Bacterial Varieties of Gangrene.

Gangrene primarily due to infection with bacteria is of the moist type, and tends to spread rapidly and to end fatally.

**Acute Infective Gangrene** usually follows trivial injuries, such as a pin-prick or a scratch. On the other hand it may ensue very early on such severe injuries as result from railway, machinery, or street accidents, where, in addition to the extensive laceration and bruising of tissues, including vessels and nerves, there is gross dirt ground into the wounds. Some virulent pyogenic organism is introduced, producing extensive stasis and interference with the venous return. The highly poisonous toxins not only lead to serious constitutional disturbances, but by their local irritant action add to the venous stasis, and so determine a rapidly-spreading gangrenous process.

*Clinical Features.*—Often within a few hours of the injury the whole part rapidly becomes painful, swollen, œdematous, and tense. The skin is at first glazed, and perhaps paler than normal, but soon assumes a dull red or purplish hue, and bullæ form on the surface. Putrefactive gases may be evolved in the tissues, and their presence is indicated by emphysematous crackling when the part is handled. The spread of the disease is so rapid that its progress is quite visible from hour to hour, and may be traced by the occurrence of red lines along the course of the lymphatics of the limb.

In the most acute cases the death of the affected part takes place so rapidly that the local changes indicative of gangrene have not time to occur, and the fact that the part is dead may be overlooked.

Rigors may occur, but the temperature is not necessarily raised—indeed it is sometimes subnormal. The pulse is small, feeble, rapid, and irregular. Unless promptly treated by amputation, death usually follows within thirty-six or forty-eight hours. Even early operation does not always avert the fatal issue, because the quantity of toxin absorbed and its extreme virulence are often more than even a robust subject can outlive.

*Prophylaxis.*—Strenuous efforts must be made to purify thoroughly all such wounds as are contaminated by earth, street dust, stable refuse, or other forms of gross dirt. The scissors

should be freely used to remove badly bruised or torn tissue, and no attempt should be made to close the wound by stitches. Rather should it be kept open with drainage tubes or iodoform gauze or worsted inserted into its corners and crevices to ensure free drainage. As the organisms associated with this condition are mostly anaërobic, the use of peroxide of hydrogen is indicated for cleansing the wound.

*Treatment.*—For acute gangrene no treatment short of amputation is of any avail, and the sooner this is done the greater is the hope of saving the patient. The limb must be amputated well beyond the apparent limits of the gangrenous area. Thorough antiseptic preparation of the region selected, and stringent precautions to avoid discharge from the already gangrenous area reaching the operation wound, are of the utmost importance. An assistant or nurse, who is to take no other part in the operation, is told off to carry out this preliminary purification; to wrap the part to be removed in carbolised towels; and to hold the limb during the operation.

When the disease has spread so high that amputation above it is impossible, the dead part may be removed, and the surface of the stump sprayed with peroxide of hydrogen and then sponged over with pure carbolic acid. Anti-streptococcic serum has apparently proved of service in a certain number of cases. The patient must be freely stimulated after the operation, and fed with nutritious fluid food.

**Malignant Œdema.**—This form of acute spreading gangrene has been shown to be due to a specific organism, the *bacillus of malignant œdema*, which is found in garden soil, dung, and various putrefying animal substances. It is anaërobic, and occurs as long, thick rods with somewhat rounded ends and several laterally placed flagella. Spores, having a very high power of resistance, form in the centre of the rods, and bulge out the sides so as to give the organisms a spindle-shaped outline. Other pathogenic organisms are often present and aid it in its action.

*Clinical Features.*—The disease has been defined as "a spreading inflammatory œdema attended with emphysema, and ultimately followed by gangrene of the skin and subjacent parts." At the bedside it is difficult, if not impossible, to distinguish it from acute infective gangrene. Both follow on the same kinds of injury and run an exceedingly rapid course. In malignant œdema, however, the incidence of the disease is mainly on the superficial parts, which become livid, indurated, œdematous, and emphysematous, and soon die. Bullæ form on

the skin, and the tissues have "a peculiar heavy but not putrid odour." The general constitutional effects of the disease are extremely severe, and death may ensue within a few hours.

The *treatment* is the same as that of acute infective gangrene, and the prognosis is even less hopeful.

In animals immunity can be produced by repeated injections of sterilised cultures or of the filtered serum of animals which have died of the disease.

**Cancrum Oris or Noma.**—This disease is believed to be due to a specific bacillus, which occurs in long delicate rods, and is chiefly found at the margin of the gangrenous area. It is most prone to attack unhealthy children from two to five years of age, especially during their convalescence from such diseases as measles, scarlet fever, or typhoid, but may attack adults when they are debilitated. It is most common in the mouth, but sometimes occurs on the vulva. In the mouth it begins as an ulcerative stomatitis, more especially affecting the gums or inner aspect of the cheek. The child lies prostrated, and from the open mouth foul-smelling saliva, streaked with blood, escapes; the face is of an ashy-grey colour, the lips dark-red and swollen. On the inner aspect of the cheek is a deeply ulcerated surface, with sloughy shreds of dark-brown or black tissue covering its base; the edges are irregular, firm, and swollen, and the surrounding mucous membrane is inflamed and œdematous. In the course of a few hours a dark spot appears on the outer aspect of the cheek and rapidly increases in size; towards the centre it is black, shading off through blue and grey into a dark-red inflamed area which extends over the cheek. The tissue implicated is at first firm and indurated, but as it loses its vitality it becomes doughy and sodden. Finally a slough forms, perforating the cheek.

Meanwhile the process spreads inside the mouth, so that the gums, the floor of the mouth, or even the jaws become gangrenous and the teeth fall out. The constitutional disturbance is severe, the temperature raised, and the pulse feeble and rapid.

The extremely fœtid odour which pervades the room or even the house the patient occupies, is usually sufficient to suggest the diagnosis of cancrum oris. It must not be mistaken for the decomposition of sordes on the teeth and gums of a debilitated patient. It is most important to recognise the disease early, otherwise treatment is of no avail.

The *prognosis* is always grave in the extreme, the main risks being general toxæmia and septic pneumonia.

*Treatment.*—The only satisfactory treatment is the thorough

removal under chloroform of all the sloughy tissue, with the surrounding zone in which the organisms are active. This is most efficiently accomplished by the knife or scissors, cutting until the tissue bleeds freely, after which the raw surface is painted with undiluted carbolic acid and dressed with iodoform gauze. It is often necessary to remove large pieces of bone when the necrotic process has implicated the jaws. The mouth must be constantly sprayed with peroxide of hydrogen, and washed out with a disinfectant and deodorant lotion, such as Condy's fluid. The patient's general condition calls for free stimulation.

The deformity resulting from these necessarily heroic measures is often not so great as might be expected, and can be further diminished by plastic operations which should be undertaken before cicatricial contraction has taken place.

*Phagedæna, Hospital Gangrene, and Diphtheritic Gangrene.*—Fortunately little need be said regarding these conditions. They are chiefly of historical interest as having constituted at one time the scourge of surgical wards, and as having been the first diseases to disappear after the introduction of antiseptic surgery.

A few days after the infliction of a wound, pain and swelling appeared. On the surface of the wound, which became dry and pale, a false membrane formed, and under this the tissues ulcerated and became gangrenous with great rapidity. The false membrane became thicker and softer as the process progressed; the skin, cellular tissue, and muscles rapidly sloughed; and not infrequently large vessels were opened into, and death resulted from hæmorrhage. High fever, diarrhœa, sleeplessness, and delirium preceded the almost invariably fatal issue.

Amputation was the only treatment which offered any prospect of recovery.

## Bed-Sores.

Bed-sores are most frequently met with in old and debilitated patients, or in those whose tissues are devitalised by acute fevers or by such chronic diseases as lead to stagnation of blood in the peripheral veins. Any interference with the nerve-supply of the skin, whether from injury or disease of the central nervous system or of the peripheral nerves, strongly predisposes to the formation of bed-sores. Prolonged and excessive pressure over a bony prominence, especially if the parts be moist with skin secretions, urine, or wound discharges, determines the

formation of the sore. Excoriations, which may develop into true bed-sores, sometimes form where two skin surfaces remain constantly apposed, as in the region of the scrotum or labium, under pendulous mammæ, or between fingers or toes confined in a splint.

*Clinical Features.*—Two clinical varieties are met with—the acute and the chronic bed-sore.

The *acute* bed-sore (Fig. 26) usually occurs over the sacrum or buttock. It comes on very rapidly after spinal injuries and in the course of certain brain diseases. The part affected becomes red and congested, while the surrounding parts are

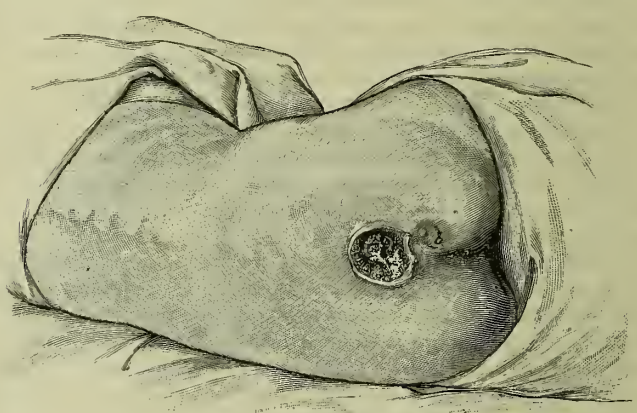


Fig. 26.—Bed-sore in a boy, æt. 16, who suffered from Fracture-dislocation of Spine in mid-dorsal region.

œdematous and swollen. Blisters form, and the skin loses its vitality and dies.

In advanced cases of general paralysis of the insane, a peculiar form of acute bed-sore beginning as bullæ, and passing on to the formation of black, dry eschars, which slowly separate, frequently occurs on such parts as the inner side of the knee, the angle of the scapula, and the heel.

The *chronic* bed-sore (Fig. 27) begins as a dusky reddish purple patch, which gradually becomes darker till it is almost black. The parts around are œdematous, and vesicles may form. These burst and expose the papillæ of the skin, which are of a greenish hue. A tough greyish-black slough forms and is slowly separated. It is not uncommon for the gangrenous area to continue

to spread both in width and in depth till it reaches the periosteum or bone. Bed-sores over the sacrum sometimes implicate the spinal canal and lead to septic spinal meningitis, which usually proves fatal.

In old and debilitated patients the septic absorption taking place from a bed-sore often proves a serious complication of other surgical conditions. From this cause, for example, many old people succumb during the treatment of a fractured thigh.

The granulating surface left on the separation of the slough, under appropriate treatment, tends to heal comparatively rapidly.

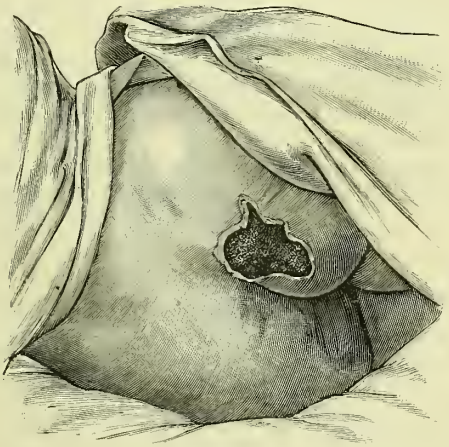


FIG. 27.—Pressure Bed-sore in an old woman with Fracture of Neck of Femur.

*Prevention of Bed-sores.*—The first essential to the prevention of bed-sores is the regular changing of the patient's position, so that no one part of the body will be continuously pressed upon for any length of time. Ring-pads of wool, air-cushions, or water-beds are necessary to remove pressure from prominent parts. Absolute dryness of the skin is all-important. At least once a day the sacrum, buttocks, shoulder-blades, heels, elbows, malleoli, or any other parts exposed to pressure must be sponged with soap and water, thoroughly dried, and then rubbed with methylated spirit, which is allowed to dry on the skin. Dusting the part with boracic acid powder not only keeps it dry, but prevents the development of bacteria in the skin secretions.

In operation cases, care must be taken that irritating chemicals

used to purify the skin, such as turpentine, ether, or strong carbolic solutions, do not collect under the patient and remain in contact with the skin of the sacrum and buttocks during the time he is on the operating-table. There is reason to believe that the so-called "post-operation bed-sore" may be due to such causes. A similar result has been known to follow soiling of the sheets by the escape of a turpentine enema.

*Treatment.*—Once a bed-sore has formed, every effort must be made to prevent its spread. Mild antiseptic lotions are used to cleanse the broken surface, and dry absorbent dressings are applied and frequently changed. It is sometimes found necessary to employ moist or oily substances, such as boracic poultices, eucalyptus ointment, or balsam of Peru, to facilitate the separation of sloughs, or to promote the growth of granulations. In patients who are not extremely debilitated the slough may be excised, the raw surface scraped and then painted with undiluted carbolic acid.

Skin-grafting is sometimes useful in covering in the large raw surface left after separation or removal of sloughs.

# CHAPTER VIII.

## BACTERIAL AND OTHER WOUND INFECTIONS.

*Erysipelas—Diphtheria—Tetanus—Hydrophobia—Anthrax—Glanders—Actinomycosis—Mycetoma—Delhi boil—Chigoe—Poisoning by insects—Snake bites.*

### Erysipelas.

Erysipelas is an acute spreading inflammation of skin or mucous membrane due to the action of a streptococcus. The organism was at one time believed to be specific as regards this disease, and was called by Fehleisen the *streptococcus erysipelatis*, but it is now generally accepted that it is the ordinary streptococcus pyogenes "of a certain degree of virulence," although the conditions which so modify it that it causes erysipelas are as yet not fully understood. Infection invariably takes place through an abrasion of the surface, although this may be so slight that it escapes observation even when sought for. With our improved methods of wound treatment, erysipelas very rarely attacks an operation wound; when it does so it is usually in wounds about the face and mouth, where it is impossible to maintain asepsis. The streptococci are found most abundantly in the lymph spaces of the affected tissue, and in the serous blebs which sometimes form on the surface, but they seldom invade the blood-stream.

Microscopically, four zones are to be recognised from without inwards in a patch of erysipelas. (1) Just beyond the reddened area is a zone in which active spread is taking place, all the lymphatic spaces being crowded with rapidly multiplying streptococci; (2) at the margin of the red area the lymph spaces are crowded with leucocytes, many of which have streptococci in their interior; (3) in a zone internal to this the inflammatory reaction is less marked, and all the free cocci have disappeared; and (4) towards the centre of the patch the tissues

have returned to the normal, no permanent structural change having taken place.

*Clinical Features.*—After an incubation period, which varies from fifteen to sixty hours, the patient complains of headache, pains in the back and limbs, loss of appetite, nausea, and very frequently there is vomiting. He has a chill or slight rigor, initiating a rise of temperature to 103°, 104°, or 105° F.; and a full bounding pulse of about 100 (Fig. 7). The tongue is foul, the breath heavy, and, as a rule, the bowels are constipated.

Around the seat of inoculation a diffuse red patch forms, varying in hue from a bright scarlet to a dull brick-red. The edges are slightly raised above the level of the surrounding skin, as may readily be recognised by gently stroking the part from the healthy towards the affected area. The skin is smooth, tense, glossy, and œdematous, with serous bullæ here and there over it. The local temperature is raised, and the part is the seat of a burning sensation and is tender to the touch, the most tender area being the actively spreading zone which lies about half an inch beyond the red margin.

The disease tends to spread spasmodically and irregularly, and the direction and extent of its progress may be recognised by mapping out the peripheral zone of tenderness. Red streaks appear along the lines of the main superficial lymphatic vessels, and the deep lymphatics may sometimes be palpated as firm, tender cords. The neighbouring glands, also, are generally enlarged and tender.

The usual systemic symptoms associated with toxæmia are present—high temperature, gastro-intestinal disturbances, frequently albuminuria, and occasionally nocturnal delirium. A moderate degree of leucocytosis (15,000 to 20,000) is usually present in well-marked cases. The degree of leucocytosis furnishes a fairly accurate index of the severity of the condition, and an extension of the erysipelas is usually accompanied by an increase in the leucocytosis.

The disease lasts for from two or three days to as many weeks, and relapses are frequent. Spontaneous resolution usually takes place, but the disease may prove fatal from absorption of toxins, involvement of the brain or meninges, or from septicæmia.

**Clinical Varieties**—*Facial erysipelas* is the commonest clinical variety, infection usually occurring through some slight abrasion in the region of the mouth or nose. From this point of origin the inflammation may spread all over the face and

scalp as far back as the nape of the neck. It stops, however, at the chin, and never extends on to the front of the neck. There is great œdema of the face, the eyes becoming closed up, and the features unrecognisable. The inflammation may spread to the meninges, the intracranial venous sinuses, the eye, or the ear, and so add to the immediate risks, and lead to serious after-consequences. In some cases the erysipelas invades the mucous membrane of the mouth, and spreads to the fauces and larynx, setting up an œdema of the glottis which may prove fatal.

*Erysipelas neonatorum* occurs in the region of the umbilicus in young infants, and usually proves fatal.

*In puerperal women* the infection may occur in .the genital tract and give rise to a dangerous form of streptococcal infection.

*Complications.*—*Diffuse suppurative cellulitis* is the most serious local complication, and results from a mixed infection with pyogenic bacteria. Small *localised superficial abscesses* may form during the convalescent stage. They are doubtless due to the action of skin bacteria which attack the tissues devitalised by the erysipelas. A persistent form of *œdema* sometimes remains after recurrent attacks of erysipelas, especially when they affect the face or the lower extremity. This condition is referred to again with elephantiasis.

*Treatment.*—The first indication in treatment is to endeavour to arrest the spread of the process. We have found that by painting with linimentum iodi, a ring half an inch broad, about an inch in front of the peripheral tender zone —not the red margin—an artificial leucocytosis is produced, and the advancing streptococci are thereby arrested. Several coats of the iodine are applied, one after the other, and this is repeated daily for several days, even although the erysipelas has not overstepped the ring. Success depends upon using the liniment of iodine (the tincture is not strong enough), and in applying it well in front of the disease.

Scarification of the skin in front of the spreading margin acts in the same way, but is painful, and requires a general anæsthetic.

To allay the pain of erysipelas perhaps the most useful local applications are ichthyol ointment (1 in 6), thiol (in 20 to 40 per cent. aqueous solution) painted on several times a day, or lead and opium fomentations.

The general treatment consists in attending to all the emunctories, in administering quinine in small—two-grain—doses every four hours, or salicylate of iron (2-5 gr. every

three hours), and in giving plenty of fluid nourishment. It is worthy of note that the anti-streptococcic serum has proved of less value in the treatment of erysipelas than might have been expected in view of the fact that the disease is due to the action of a streptococcus.

It is not necessary to isolate cases of erysipelas, provided the usual precautions against carrying infection from one patient to another are rigidly carried out.

## Diphtheria.

Diphtheria is an acute infectious disease due to the action of a specific bacterium, the *bacillus diphtheriæ* or *Klebs-Löffler bacillus.*

The commonest site of infection is the fauces and soft palate, where at first the effects are local, and consist in the formation of a false membrane composed of necrosed epithelium, fibrin, leucocytes, and red blood corpuscles. As the disease progresses, a general systemic toxin poisoning, associated with great muscular weakness, a tendency to syncope, and albuminuria, ensues. After the acute symptoms have passed off, various localised paralyses, affecting particularly the nerves of the palatal and orbital muscles, develop in from 15 to 20 per cent. of cases.

The disease is usually transmitted from one patient to another, but it may be contracted from cats, fowls, or through the milk of infected cows. Cases have occurred in which the surgeon has carried the infection from one patient to another through neglect of antiseptic precautions.

*Clinical Features.*—The incubation period varies from two to seven days. On the first or second day of the disease redness and swelling of the mucous membrane of the pharynx, tonsils, and palate are well marked, and small, circular greenish or grey patches of false membrane begin to appear. These rapidly increase in area and thickness, till they coalesce and form a complete covering to the parts. In the pharynx the false membrane is less adherent to the surface than it is in the air-passages. The lymphatic glands behind the angle of the jaw enlarge and become tender, and may suppurate from superadded infection. There is pain on swallowing, and often ear-ache; and the patient speaks with a nasal accent. He becomes weak and anæmic, and loses his appetite. There is often albuminuria. Leucocytosis is usually well marked before the injection of antitoxin; after the injection there is usually a diminution in the number

of leucocytes. The false membrane may become separated and cast off, after which the patient gradually recovers. Death may take place from asthenia or from sudden syncope during some slight exertion.

The disease may arise in the larynx, although, as a rule, it spreads thence from the pharynx. It first manifests itself by a short, dry, croupy cough, and hoarseness of the voice. The difficulty in breathing usually first takes place suddenly during the night, and once it begins, it rapidly gets worse. Inspiration becomes noisy, sometimes stridulous or metallic or sibilant, and there is marked indrawing of the epigastrium and lower ribs. The voice becomes more rough, the cough more severe, and the patient very restless. The difficulty of breathing occurs in paroxysms, which gradually increase in frequency and severity until at length the exhausted patient becomes asphyxiated and dies. The duration of the disease varies from a few hours to four or five days.

*Diagnosis.*—Diphtheria has to be diagnosed from suppurative tonsillitis and from croup. In true diphtheria, when the false membrane is removed, a raw bleeding surface is left. So much doubt exists as to the real nature of membranous croup and its relationship to true diphtheria, that when the diagnosis between the two is uncertain, the safest plan is to treat the case as one of diphtheria. The finding of the Klebs-Löffler bacillus is the only conclusive evidence of the disease. The bacillus may be obtained by swabbing the throat with a piece of aseptic —not antiseptic—cotton wool or clean linen rag held in a pair of forceps, and rotated so as to entangle portions of the false membrane or exudate. The swab thus obtained is placed in a test-tube previously sterilised by having had some water boiled in it. When a bacteriological examination is impossible, or when the clinical features do not coincide with the results obtained, the patient should always be treated on the assumption that he suffers from diphtheria.

*Treatment.*—An attempt may be made to destroy or to counteract the organisms by swabbing the throat with strong antiseptic solutions, such as 1 in 1000 corrosive sublimate or 1 in 30 carbolic acid, or by spraying with peroxide of hydrogen.

The antitoxic serum is our sheet-anchor in the treatment of diphtheria, and recourse should be had to its use as early as possible. So great has been the lowering of the mortality by its use that a serious responsibility rests upon the practitioner who fails to give his patient the benefit of this method of treatment.

The initial dose should be a large one, certainly not less than 3000 units, and a further injection of 1500 units should be given in twelve hours if marked improvement does not take place. The earlier the injection, and the more concentrated the serum, the better are the results.

Within twenty-four hours of the injection the local symptoms usually begin to subside, and the membrane separates and is thrown off. At the same time the temperature falls, the pulse becomes slower, and the general condition of the patient improves. Beyond certain erythematous and urticarial rashes, and transient joint pains, which sometimes occur, no inconvenience attends the use of the serum. It may therefore be given with benefit and safety even while the diagnosis is still in doubt, or as a prophylactic measure to those exposed to the disease—for example, in public schools.

The general strength of the patient must be maintained by abundance of liquid food and stimulants.

Difficulty of swallowing nourishment may be met by the use of a stomach tube passed either through the mouth or nose. When this is impracticable, nutrient enemata are called for.

The introduction of the antitoxin treatment has greatly diminished the number of cases in which it becomes necessary to have recourse to intubation or tracheotomy on account of interference with respiration.

Intubation consists in introducing through the mouth into the larynx a tube which allows the patient to breathe freely during the period while the membrane is becoming separated and thrown off. This is best done with the apparatus of O'Dwyer; but when this instrument is not available, a simple gum-elastic catheter with a terminal opening (as suggested by Macewen and Annandale) is equally efficient.

It is only in exceptional cases that the operation of tracheotomy is called for.

*Diphtheria in other situations.*—The diphtheritic process may spread from the pharynx to the nasal cavities, causing blocking of the nares, with a profuse ichorous discharge from the nostrils, and sometimes severe epistaxis. The inflammation may spread along the nasal duct to the conjunctiva. The middle ear also may become involved by spread along the Eustachian tube.

In children diphtheria may occur in the vulva, vagina, prepuce, or glans penis, and give rise to difficulty in diagnosis, which is only cleared up by microscopic examination of the discharge.

## Tetanus.

Tetanus is a general disease resulting from the infection of a wound by a specific micro-organism, the *bacillus tetani*, and characterised by tonic contractions of one or more groups of muscles, with periodic exacerbations.

*Etiology and Morbid Anatomy.*—The tetanus bacillus is a slender rod-shaped organism. Each bacillus forms a single large

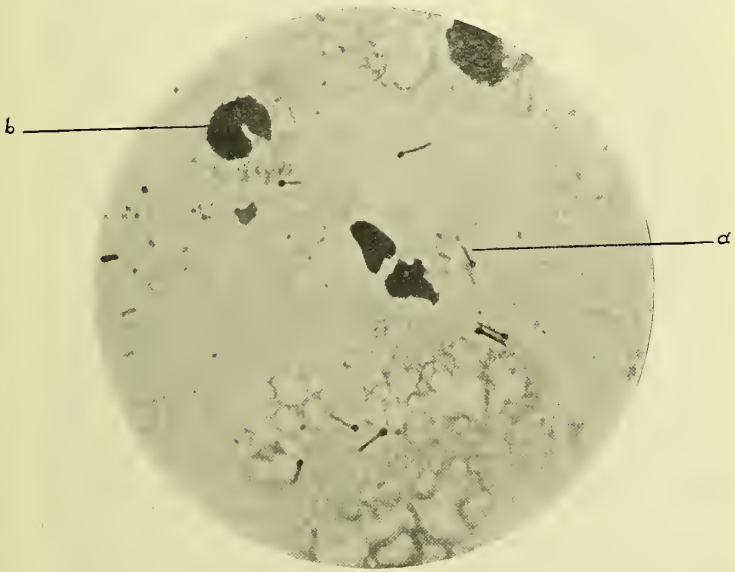



Fig. 28.—Bacillus of Tetanus from wound of infection. × 1000 diam.
*a* = Bacillus with spore—drum-stick bacillus.
*b* = Leucocytes.

spore, which is usually placed at one end and gives to the organism the shape of a drum-stick (Fig. 28). The spores are highly resistant to chemical germicidal agents and to conditions of dryness, and they even survive boiling for five minutes.

The organism, which is a perfect anaërobe, is very widely distributed in nature, and is readily found in garden earth, dung-heaps, and stable refuse. It can often be obtained also in the pus from the wound of infection in patients suffering from the disease, but it does not invade the body generally. Such wounds are usually small, unhealthy, and lined with necrotic

tissue from which the special bacillus may be isolated, as well as other organisms—pyogenic or putrefactive—with which it is usually associated.

It is now believed that a broken surface, however small, is essential to the inoculation of the virus, and that no such thing as an "idiopathic" variety of tetanus exists.

It would appear, from experimental evidence, that the spores are the active agents in producing the disease, and that the presence of effused blood and some source of local irritation, such as a splinter of wood or other foreign body, favour their development. There is also reason to believe that the tetanus bacillus acts more certainly when introduced along with aërobic organisms, which, by using up the oxygen in the tissues, leave it a suitable environment.

On post-mortem examination of patients who have died of tetanus very few lesions are to be detected. The commonest are congestion of the central nervous system, notably the grey matter of the pons and medulla, and degenerative changes in the ganglion cells of the spinal cord.

*Clinical Features.*—The characteristic symptoms of tetanus do not, as a rule, appear earlier than the fourth or fifth day after the infliction of the wound, but the incubation period may extend to three weeks, and the wound may be quite healed before the disease declares itself. Usually, however, the wound is inflamed and suppurating, with ragged and sloughy edges. A slight feverish attack may mark the onset of the tetanic condition, or the patient may feel perfectly well until the spasms begin. If very careful observations be made, it may be found that the muscles in the immediate neighbourhood of the wound are the first to become contracted; but in the majority of instances the patient's first complaint is of pain and stiffness in the muscles of mastication, notably the masseter, so that he has difficulty in opening the mouth—hence the popular name "lock-jaw." The other facial muscles soon share in the rigidity, and the face assumes a fixed, mask-like aspect. The angles of the mouth may be retracted, producing a grinning expression known as the *risus sardonicus*.

The next muscles to become stiff and painful are those of the neck, especially the sterno-mastoid and trapezius. The patient is inclined to attribute the pain and stiffness to exposure to cold or rheumatism. At an early stage the diaphragm and the muscles of the anterior abdominal wall become contracted; later the muscles of the back and thorax are involved; and lastly those of the limbs. Although this is the typical order of

involvement of the different groups of muscles, it is not always adhered to.

To this permanent tonic contraction of the muscles there are soon superadded clonic spasms. These spasms are at first slight and transient, with prolonged intervals between the attacks, but rapidly tend to become more frequent, more severe, and of longer duration, until eventually the patient simply passes out of one seizure into another.

The distribution of the spasms varies in different cases; in some it is confined to particular groups of muscles, such as those of the neck, back, abdominal walls, or limbs; in others all these groups are simultaneously involved.

When the muscles of the back become spasmodically contracted, the body is raised from the bed, sometimes to such an extent that the patient rests only on his heels and occiput—the position of *opisthotonos*. Lateral arching of the body from excessive action of the muscles on one side—*pleurosthotonos*—is not uncommon, the arching usually taking place towards the side on which the wound of infection exists. Less frequently the body is bent forward so that the knees and chin almost meet (*emprosthotonos*). Sometimes all the muscles simultaneously become rigid, so that the body assumes a statuesque attitude (*orthotonos*). When the thoracic muscles, including the diaphragm, are thrown into spasm, the patient experiences a distressing sensation as if he were gripped in a vice, and has extreme difficulty in getting breath. Between the attacks the limbs are kept rigidly extended. The clonic spasms may be so severe as to rupture muscles or even to fracture a long bone.

As time goes on, the clonic exacerbations become more and more frequent, and the slightest external stimulus, such as the feeling of the pulse, a whisper in the room, a noise in the street, a draught of cold air, the effort to swallow, a question addressed to the patient or his attempt to answer, is sufficient to determine an attack. The movements are so forcible and so continuous that the nurse has great difficulty in keeping the bed-clothes on the patient, or even in keeping the patient in bed.

The general condition of the patient is pitiful in the extreme. He is fully conscious of the gravity of the disease, and his mind remains clear to the end. The suffering induced by the cramp-like spasms of the muscles keeps him in a constant state of fearful apprehension of the next seizure. Sleep is usually impossible until it results from utter exhaustion.

The temperature is moderately raised (100° to 102° F.), or may remain normal throughout. Shortly before death very high temperatures (110° F.) have been recorded, and it has been observed that the thermometer sometimes continues to rise after death, and may reach as high as 112° F. or more.

The pulse corresponds with the febrile condition. It is accelerated during the spasms, and may become exceedingly rapid and feeble before death, probably from paralysis of the vagus. Sudden death from cardiac paralysis or from cardiac spasm is not uncommon.

The respiration is affected in so far as the spasms of the respiratory muscles produce dyspnœa, and a feeling of impending suffocation which adds to the horrors of the disease. Death from respiratory spasm sometimes takes place during a severe fit.

One of the most constant symptoms is a copious perspiration, the patient being literally bathed in sweat. The urine is diminished in quantity, but as a rule is normal in composition; as in other acute infective conditions, albumen and blood may be present. Retention of urine may result from spasm of the urethral muscles. The appetite is lost, the tongue foul, and constipation most obstinate.

Gradually the patient becomes exhausted. The fits may cease some time before death, or, on the other hand, death may occur during a paroxysm from fixation of the diaphragm and arrest of respiration.

**Clinical Varieties of Tetanus.**—*Acute or Fulminating Tetanus.*—This variety has been described as the type of the disease. It is characterised, as we have seen, by the rapidity of its progress, the severity of its symptoms, and its all but universally fatal issue in spite of treatment, death taking place in from one to four days.

*Chronic Tetanus.*—The difference between this and acute tetanus is mainly one of degree. Its incubation period is longer, it is more slow and insidious in its progress, and it never reaches the same degree of severity. Trismus is the most marked and constant form of spasm; and while the trunk muscles may be involved, those of respiration as a rule escape. Every additional day the patient lives adds to the probability of his ultimate recovery. When the disease does prove fatal it is from exhaustion, and not from respiratory or cardiac spasm. The usual duration is from six to ten weeks.

*Trismus.*—This term is used to denote a form of tetanic spasm limited to the muscles of mastication. It is really a mild form of chronic tetanus, and the prognosis is good. It

must be diagnosed clinically from inflammatory lesions of the pharynx or of the alveoli of the jaws, and from affections of the temporo-maxillary articulation.

*Tetanus Neonatorum* is a form of tetanus occurring in infants of about a week old. Infection takes place through the umbilicus and manifests itself clinically by spasms of the muscles of mastication. It is almost invariably fatal within a few days.

*"Head" or "Cephalic" Tetanus.*—This is a peculiar variety of traumatic tetanus which follows injuries to the head. It is characterised by the occurrence, on the same side as the head injury, of more or less complete paralysis of the facial muscles supplied by the seventh nerve. This paralysis of the facial nerve fibres is believed to be due to a selective action of one of the tetanus toxins on the nerve centre in the medulla, as well as a local action on the peripheral nerve-endings. There is usually well-marked trismus, and other tetanic symptoms, varying in severity, ultimately supervene. In head tetanus the muscles of deglutition are often specially involved—hence the name *tetanus hydrophobicus*. Recovery is exceptional.

*Differential Diagnosis.* — There is little difficulty, as a rule, in diagnosing a case of fulminating tetanus, but there are several conditions with which it may occasionally be confused. *Strychnine poisoning.*—Here the spasms come on immediately after the patient has taken a toxic dose of the drug; they are clonic in character, but the muscles are relaxed during the fits. If the dose is not lethal the spasms soon cease. In *hydrophobia* a history of having been bitten by a rabid animal is usually forthcoming; the spasms, which are clonic in character, affect chiefly the muscles of respiration and deglutition, and pass off entirely in the intervals between attacks. *Cerebro-spinal meningitis* and *basal meningitis* present certain superficial resemblances to tetanus, but there is no trismus, and the spasms chiefly affect the muscles of the neck and back. Certain cases of *hæmorrhage into the lateral ventricles* of the brain also simulate tetanus, but an analysis of the symptoms will prevent errors in diagnosis. *Hysteria and catalepsy* may assume characters resembling those of tetanus, but beyond the spasms there is nothing in common between these diseases. Lastly, in the *tetany* of children, or that following operations on the thyroid gland, the spasms are of a jerking character, affect chiefly the hands and fingers, and yield to medicinal treatment.

*Prophylaxis.*—The prevention of tetanus depends on thorough purification of all wounds which have been liable to infection by

earth, stable refuse, or street dust. All instruments and appliances used for operations on tetanic patients must be sterilised by *prolonged* boiling before being put away.

*Treatment.*—When symptoms of the disease have appeared, the indications for treatment are :—(1) *To arrest the formation and introduction into the circulation of further supplies of the toxin.* To this end the wound must be thoroughly purified by the usual means, the unhealthy walls being bodily excised and the raw surface left sponged over with carbolic acid and dressed with iodoform gauze. Amputation is seldom called for to meet this indication.

(2) *To promote excretion of the toxins already absorbed* by ensuring free action of the bowels, kidneys, and skin. The injection of saline solution into the veins or cellular tissue may be had recourse to with this object.

(3) *To counteract the toxins already in circulation.*—The value of the anti-tetanic serum is still in doubt. While it is true that a degree of immunity may be produced in animals by means of antitoxic serum, there is at present little evidence that any material benefit follows its use in fully developed, acute progressive tetanus in the human subject. The vast majority of the cases in which the serum has been employed and the patient has recovered have been of the chronic type of the disease, which naturally tends to spontaneous cure. In spite of these facts, however, and in view of the success which has followed the use of other sera, we are bound to give the patient the benefit of what is meanwhile the only rational treatment offering any hope of cure. The earlier the serum is injected the greater is that hope, and the initial dose must be a large one—not less than 60 c.c. Several smaller doses may subsequently be given within the first twenty-four hours if the symptoms do not abate. The best results hitherto seem to have been obtained by Tizzoni's serum.

In order to bring the antitoxin into direct relation with the central nervous system, it has been injected into the sub-arachnoid space by lumbar puncture. Injection directly into the cranial cavity has been given up on account of the risks attending the procedure.

(4) *To conserve the patient's strength by preventing or diminishing the severity of the spasms.*—The patient should be placed in a quiet room, and every form of disturbance rigidly avoided. Sedatives must be given in large doses. Chloral is perhaps the best, and the patient should rarely have less than 150 grains in twenty-four hours. When he is unable to swallow

it should be given by the rectum. The administration of chloroform is of great value in conserving the strength of the patient by abolishing the spasms, and enabling the attendants to administer nourishment or drugs either through a stomach tube or by the rectum. Extreme elevation of temperature is met by tepid sponging. It is necessary to use the catheter if retention of urine occurs.

### Hydrophobia.

Hydrophobia is an acute infective disease following on the bite of a rabid animal. The analogies existing between hydrophobia and other diseases of undoubted bacterial origin justify the belief that this disease is due to a specific organism, although it has not yet been demonstrated. In this country it most commonly follows the bite or lick of a rabid dog or cat. The virus appears to be communicated through the saliva of the animal, and the disease is most likely to develop when the patient is infected on the face or some other uncovered part. Only about one person out of three bitten by animals proved to be rabid suffers from the disease.

*Rabies in the Dog.*—The animal becomes depressed and listless, develops a depraved appetite, eating all kinds of rubbish and filth; is peculiarly irritable and snappish towards other dogs; and when it moves about, takes no notice of surrounding objects. The bark becomes hoarse; a thick ropy mucus collects in the mouth, and the creature has difficulty in swallowing, although it makes violent attempts to lap water. Paralysis of the lower jaw and of the limbs precedes death, which usually takes place in five or six days. The wild fury which is generally supposed to characterise a mad dog is usually conspicuous by its absence.

A dog which has bitten a person should on no account be killed until its condition has been proved one way or the other. Should rabies develop and its destruction become necessary, the head and spinal cord should be retained and forwarded, packed in ice, to a competent observer. Much anxiety to the person bitten and to his friends would be avoided if these rules were observed, because in many cases it will be shown that the animal did not after all suffer from rabies, and that the patient consequently runs no risk. If, on the other hand, rabies is proved to be present, the patient should be submitted to the Pasteur treatment.

*Clinical Features in Man.*—There is almost always a history of the patient having been bitten or licked by an animal supposed to suffer from rabies. The incubation period averages about forty days, but varies from a fortnight to seven or eight months, and is shorter in young than in old persons. The original wound has long since healed, and beyond a slight itchiness or pain shooting along the nerves of the part, shows no sign of disturbance. A few days of general malaise, with chills and giddiness, precede the onset of the acute manifestations, which affect chiefly the muscles of deglutition and respiration. One of the earliest signs is that the patient has periodically a sudden catch in his breathing "resembling what often occurs when a person goes into a cold bath." This is due to spasm of the diaphragm, and is frequently accompanied by a loud-sounding hiccough, likened by the laity to the barking of a dog. Difficulty in swallowing fluids may be the first symptom.

The spasms rapidly spread to all the muscles of deglutition and respiration, so that the patient not only has the greatest difficulty in swallowing, but has a constant sense of impending suffocation. To add to his distress, a copious secretion of viscid saliva fills his mouth. Any voluntary effort, as well as all forms of external stimuli, only serves to aggravate the spasms which are always induced by the attempt to swallow fluid, or even by the sound of running water.

The temperature is raised; the pulse is small, rapid, and intermittent, and the urine may contain sugar and albumen.

The mind may remain clear to the end, or the patient may have delusions, supposing himself to be surrounded by terrifying forms. There is always extreme mental agitation and despair, and the sufferer is in constant fear of his impending fate. Happily the inevitable issue is not long delayed, death usually occurring from exhaustion in from two to four days from the onset. The symptoms of the disease are so characteristic that there is no difficulty in diagnosis. The only condition with which it is liable to be confused is the variety of cephalic tetanus in which the muscles of deglutition are specially involved—the so-called tetanus hydrophobicus.

*Prophylaxis.*—The bite of an animal suspected of being rabid should be cauterised at once by means of the actual or Paquelin cautery, or by a strong chemical escharotic such as pure carbolic acid, after which antiseptic dressings are applied.

It is, however, to Pasteur's *preventive inoculation* that we must look for our best hope of averting the onset of symptoms. "It may now be taken as established that a grave responsibility rests on those concerned if a person bitten by a mad animal is not subjected to the Pasteur treatment" (Muir and Ritchie).

This method is based on the fact that the long incubation period of the disease admits of the patient being inoculated with a modified virus producing a mild attack, which protects him from the natural disease—on the same principle as vaccination for small-pox.

*Treatment.*—When the symptoms have once developed they can only be palliated. The patient must be kept absolutely quiet and free from all sources of irritation. The spasms may be diminished by means of chloral and bromides, or by chloroform inhalation. There is great difficulty in feeding the patient, and all nourishment and stimulants may require to be administered by the rectum.

## Anthrax.

Anthrax is a comparatively rare bacterial disease communicable to man from certain of the lower animals, such as sheep, oxen, horses, deer, and other herbivora. In animals it is characterised by symptoms of acute general septic poisoning, and, from the fact that it produces a marked enlargement of the spleen, is known in veterinary surgery as "splenic fever."

The *bacillus anthracis* (Fig. 29), to the action of which the disease has been proved to be due, is the largest of the known pathogenic bacteria. It occurs in groups or in chains made up of numerous bacilli, each measuring from 6 to 8 $\mu$ in length.

The organisms are found in enormous numbers throughout the bodies of animals which have died of anthrax, and are readily recognised and cultivated.

Sporulation only takes place outside the body, probably because free oxygen is necessary to the process. In the spore-free condition, the organisms are readily destroyed by ordinary germicides, such as heat, dryness, or chemicals, and by the

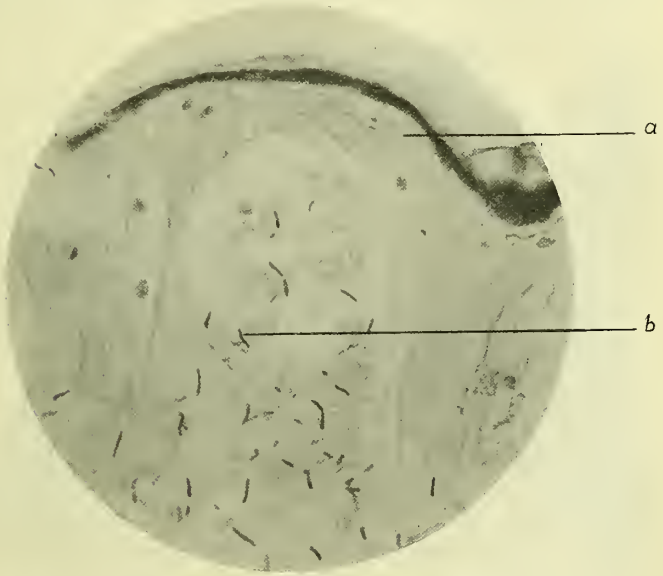



FIG. 29.—Bacillus of Anthrax from skin vesicle in case of malignant pustule. × 400 diam.

*a* = Altered epithelium over small vesicle. *b* = Anthrax bacilli in vesicle.

gastric juice. The spores, on the other hand, have a high degree of resistance. Not only do they remain viable in the dry state for long periods, even up to a year, but they survive boiling for five minutes, and must be subjected to dry heat at 140° C. for several hours before they are destroyed.

*Clinical Varieties of Anthrax.*—In man, anthrax may manifest itself in one of three clinical forms.

It may be transmitted by means of spores or bacilli directly from a diseased animal to those who, by their occupation or

otherwise, are brought into contact with it—for example, shepherds, butchers, veterinary surgeons, or hide-porters. The path of infection is usually through an abrasion of the skin, and the primary manifestations are local, constituting what is known as *the malignant pustule.*

In other cases the disease is contracted through the inhalation of the dried spores into the respiratory passages. This occurs oftenest in those who work amongst wool, fur, and rags, and an



Fig. 30.—Malignant pustule in neck of man, æt. 45, showing dark slough in centre surrounded by ring of vesicles; and œdema of face and neck. Treated by excision. Recovery.

affection resembling an acute septic pneumonia of great virulence ensues. This affection is known as *wool-sorter's disease*, and is almost universally fatal.

There is reason to believe that infection may also take place by means of spores ingested into the alimentary canal in meat or milk derived from diseased animals, or in infected water. The symptoms which follow are those of an acute and severe gastro-intestinal affection, and the mesenteric glands become greatly enlarged.

**Clinical Features of Malignant Pustule.**—We shall here

confine ourselves to the consideration of the local lesion as it occurs in the skin—*the malignant pustule* (Fig. 30).

The point of infection of malignant pustule is usually on an uncovered part of the body, such as the face, hands, arms, or back of the neck, and the wound of infection may be exceedingly minute. After an incubation period varying from a few hours to three or four days, a small red nodule, surrounded by a reddish-blue bleb containing clear or blood-stained fluid, appears at the seat of inoculation. This is accompanied by a slight burning pain and intense itchiness. The bleb soon bursts and forms a black, dried scab, around which one or more rings of small vesicles form. Outside this the skin becomes indurated and swollen, and a widespread œdema occurs. When the seat of inoculation is in the vicinity of the neck, this œdema may implicate the larynx and lead to dangerous interference with respiration. The neighbouring lymphatic glands soon become enlarged and tender.

The risk to the life of the patient in malignant pustule is that of the disease becoming generalised—*anthracæmia*. When this occurs it shows itself in the course of forty-eight to sixty hours in the form of fever, with a temperature of 102° to 104° F., severe pains in the limbs, diarrhœa, hæmaturia, and great weakness. The patient is usually remarkably free from anxiety and distress, even when dangerously ill, and dies in the course of from five to eight days with symptoms of collapse.

*Morbid Anatomy of Malignant Pustule.*—The central slough is composed of necrosed tissue and altered blood. The surrounding skin is intensely congested and œdematous, and the stratum corneum is raised as a blister from the rete Malpighii. The bacilli are found in the peripheral portion of the slough, in the vesicles, and in the adjacent lymphatics.

*Differential Diagnosis.*—The clinical features which have been described above serve to distinguish malignant pustule from an ordinary boil or carbuncle, and from the other acute infective conditions with which it is liable to be confused. In doubtful cases a bacteriological examination should be made. Inquiry should also be made as to the possibility of the patient having been in contact with infected material either in the ordinary course of his occupation or in any other way.

*Prognosis.*—If left to itself the disease is frequently fatal. The mortality is greatest when the disease attacks the face or neck, and least when the inferior extremity is affected.

*Prophylaxis.*—Any wound suspected of being infected by the

anthrax bacillus should at once be cauterised with the actual cautery, then sponged over with pure carbolic acid, and dressed antiseptically.

*Treatment.*—The best results hitherto obtained have followed the use of the serum introduced by Sclavo, which appears to act by inducing a defensive phagocytosis, rather than by neutralising toxins. The initial dose is 40 c.c., and if the serum is given early in the disease, the beneficial effects are manifest in a few hours. When the serum treatment is not available, the whole of the affected area should be excised without delay, and the actual cautery and pure carbolic acid freely applied to the raw surface.

When complete excision is impracticable on account of the situation or extent of the disease, or its relation to important structures, the whole of the indurated area should be freely incised, and after clipping away all necrotic tissue with scissors, the raw surface should be cauterised.

The subcutaneous injection of strong solutions of carbolic acid or corrosive sublimate has in some cases yielded satisfactory results.

It is only fair to state, however, that the experience of some observers seems to indicate that the results obtained by leaving the pustule to nature and merely protecting it with an antiseptic dressing are equally good.

The general treatment consists in feeding and stimulating the patient as freely as possible. Quinine, in 5 to 10 grain doses every four hours, and powdered ipecacuanha, in 40 to 60 grain doses every four hours, have also been employed with apparent benefit.

## Glanders.

Glanders is due to the action of a specific bacterium, the *bacillus mallei*, which resembles the tubercle bacillus, save that it is somewhat shorter and broader, and does not stain by Gramm's method. It requires higher temperatures for its cultivation than the tubercle bacillus, and its growth on potato is of a characteristic chocolate-brown colour, with a greenish-yellow ring at the margin of the growth. The bacillus mallei retains its vitality for long periods under ordinary conditions, but is readily killed by heat and chemical antiseptics. It does not form spores.

*Clinical Features.*—Both in the lower animals and in man

the bacillus gives rise to two distinct types of disease—*acute glanders*, and *chronic glanders or farcy*.

**Acute Glanders** is most commonly met with in the horse and in other equine animals, horned cattle being immune. It affects the septum of the nose and adjacent parts, firm, translucent, greyish nodules containing lymphoid and epithelioid cells appearing in the mucous membrane. These nodules subsequently break down in the centre, forming irregular ulcers, which are attended with profuse discharge, and marked inflammatory swelling. The cervical lymphatic glands, as well as the lungs, spleen, and liver, may be the seat of secondary nodules.

*In man* acute glanders is commoner than the chronic variety. Infection always takes place through an abraded surface, and usually on one of the uncovered parts of the body—most commonly the skin of the hands, arms, or face; or on the mucous membrane of the mouth, nose, or eye. The disease has been acquired by accidental inoculation in the course of experimental investigations in the laboratory, and proved fatal. The incubation period is from three to five days.

The *local* manifestations are pain and swelling in the region of the infected wound, with inflammatory redness around it and along the lines of the superficial lymphatics. In the course of a week, small, firm nodules, with an œdematous, inflammatory base, appear, and are rapidly transformed into pustules. These may occur on the face and in the vicinity of joints, and may be mistaken for the eruption of small-pox.

After breaking down, these pustules give rise to irregular ulcers, which by their confluence lead to extensive destruction of skin. Sometimes the nasal mucous membrane becomes affected and produces a discharge—at first watery, but later sanious and purulent. Necrosis of the bones of the nose may take place, in which case the discharge becomes peculiarly offensive. In nearly every case metastatic abscesses form in different parts of the body, such as the lungs, joints, or muscles.

During the development of the disease the patient feels ill, complains of headache and pains in the limbs, the temperature rises to 104° or even to 106° F., and assumes a pyæmic type. The pulse becomes rapid and weak. The tongue is dry and brown. There is profuse sweating, albuminuria, and often insomnia with delirium. Death may take place within a week, but more frequently occurs during the second or third week.

*Differential Diagnosis.*—There is nothing characteristic in the site of the primary lesion in man, and the condition may, during the early stages, be mistaken for a boil or carbuncle, or

for any acute inflammatory condition. Later it may simulate acute articular rheumatism, or may manifest all the symptoms of acute septicæmia or pyæmia. The diagnosis is established by the recognition of the bacillus. Veterinary surgeons attach great importance to the malleine test as a means of diagnosis.

*Treatment.*—Excision of the primary nodule, followed by cauterisation with a red-hot iron and sponging with pure carbolic acid, should be carried out, provided the condition is sufficiently limited to render complete removal practicable.



Fig. 31.—Chronic Glanders in a girl æt. 15. Shows Multiple Ulcers and Enlarged Glands.

When secondary abscesses form in accessible situations they must be incised, scraped, disinfected, and drained. The general treatment is carried out on the same lines as in other acute infective diseases.

**Chronic Glanders.**—*In the horse* the chronic form of glanders is known as *farcy*, and follows infection through an abrasion of the skin, involving chiefly the superficial lymphatic vessels and glands. The lymphatics become indurated and nodular, constituting what veterinarians call *farcy pipes* and *farcy buds.*

*In man* also the clinical features of the chronic variety of the

disease are somewhat different from those of the acute form. Here, too, infection takes place through a broken cutaneous surface, and leads to a superficial lymphangitis with nodular thickening of the lymphatics (*farcy buds*). The neighbouring glands soon become swollen and indurated. The primary lesion meanwhile inflames, suppurates, and, after breaking down, leaves a large, irregular ulcer with thickened edges and a foul, purulent or bloody discharge. The glands break down in the same way and lead to wide destruction of skin, and the resulting sinuses and ulcers are exceedingly intractable (Fig. 31). Secondary deposits in the subcutaneous tissue, the muscles, and other parts are not uncommon, and the nasal mucous membrane may become involved. The disease often runs a very chronic course, extending to four or five months, or even longer. Recovery takes place in about 50 per cent. of cases, but the convalescence is very prolonged, and at any time the disease may assume the characters of the acute variety and speedily prove fatal.

The *differential diagnosis* is often very difficult. The ulcerations of farcy have to be distinguished from those of tubercle, syphilis, and other forms of infective granulomata. In the chronic nodules it is often impossible to demonstrate the bacillus.

*Treatment.*—Limited areas of disease should be completely excised, and disinfected with pure carbolic acid. When abscesses have formed they should be scraped and disinfected.

The general condition of the patient must be improved by tonics, good food, and favourable hygienic surroundings. In some cases potassium iodide acts beneficially.

## Actinomycosis.

Actinomycosis is a chronic disease due to the action of an organism somewhat higher in the vegetable scale than ordinary bacteria—the *streptothrix actinomyces* or *ray fungus.*

*Etiology and Morbid Anatomy.*—The actinomyces, which has never been met with outside the body, gives rise in oxen, horses, and other animals to tumour-like masses composed of granulation tissue ; and in man to chronic suppurative processes which may result in a condition resembling chronic pyæmia. The actinomyces is more complex in structure than other pathogenic organisms, and occurs in the tissues in the form of small, round, semi-translucent bodies, about the size of a pin-head or less, and consisting of colonies of the fungus. On account of their yellow tint they are spoken of as "sulphur grains." Each

colony is made up of a series of thin, interlacing, and branching *filaments*, some of which are broken up so as to form masses or chains of *cocci*; and around the periphery of the colony are elongated, pear-shaped, hyaline, *club-like bodies* (Fig. 32).

Infection is believed to be conveyed by the husks of cereals, especially barley; and the organism has been found adhering to particles of grain embedded in the tissues of animals suffering from the disease. In human subjects there is often a history of

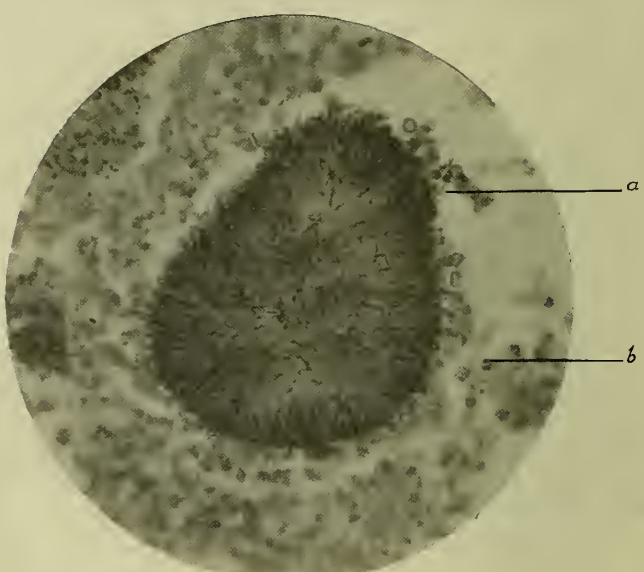



Fig. 32.—Colony of Actinomyces. × 400 diam.
*a* = Filaments of streptothrix actinomyces. *b* = Pus cells.

exposure to infection from such sources, and the disease is said to be most common during the harvesting months.

Around each colony of actinomyces is a zone of granulation tissue in which suppuration usually occurs, so that the fungus comes to lie in a bath of greenish-yellow pus. As the process spreads these purulent foci become confluent and form abscess cavities. When metastasis takes place, as it occasionally does, the fungus is transmitted by the blood-vessels, as in pyæmia.

*Clinical Features.*—In man the disease may be met with in

the skin, the organisms gaining access through an abrasion, and spreading by the formation of new nodules in the same way as tuberculosis.

The region of the mouth and jaws is one of the commonest sites of surgical actinomycosis. Infection takes place, as a rule, along the side of a carious tooth, and spreads to the lower jaw. A swelling is slowly and insidiously developed, and when the loose connective tissue of the neck becomes infiltrated, the spread is more rapid. The whole region becomes infiltrated and swollen, and the skin ultimately gives way and free suppuration occurs, resulting in the formation of sinuses. The characteristic greenish-grey or yellow granules are seen in the pus, and when examined microscopically reveal the colonies of actinomyces.

Less frequently the upper jaw becomes affected, and the disease may spread to the base of the skull and brain. The vertebræ may become involved by infection taking place through the pharynx or œsophagus, and leading to a condition simulating tuberculous disease of the spine. When it implicates the intestinal canal and its accessory glands, the lungs, pleura and bronchial tubes, or the brain, the disease is not amenable to surgical treatment.

*Differential Diagnosis.*—The conditions likely to be mistaken for surgical actinomycosis are sarcoma, tubercle, and syphilis. In the early stages the differential diagnosis is exceedingly difficult. In many cases it is only possible when suppuration has occurred and the fungus can be demonstrated.

The slow destruction of the affected tissue by suppuration, the absence of pain, tenderness, and redness simulate tuberculosis, but the absence of glandular involvement may serve to distinguish it.

Syphilitic lesions are liable to be mistaken for actinomycosis, all the more that in both diseases improvement follows the administration of iodides. When it affects the lower jaw, in its early stages, actinomycosis may closely simulate a periosteal sarcoma.

The recognition of the fungus is the crucial point in diagnosis.

*Prognosis.*—Spontaneous cure rarely occurs. When the disease implicates internal organs it is almost always fatal. On external parts the destructive process gradually spreads, and the patient eventually succumbs to superadded septic infection. When from its situation the primary focus admits of removal the prognosis is more favourable.

*Treatment.*—The only surgical treatment to be considered is the early and free removal of the affected tissues. After

excision the wound is cauterised by the actual cautery and sponged over with pure carbolic acid. The cavity left is packed with iodoform gauze, no attempt being made to close the wound.

The use of the X-rays, combined with the administration of iodides in large doses, is of great benefit, and in cases in which operative treatment is impracticable, is the most reliable measure at our disposal.

Mycetoma, or Madura Foot.—Mycetoma is a chronic disease due to an organism resembling that of actinomycosis, but not identical with it. It is endemic in certain tropical countries, and is most frequently met with in India. Infection takes place through an abrasion of the skin, and the disease usually occurs on the feet of adult males who work barefooted in the fields.

*Clinical Features.*—The disease begins on the foot as an indurated



Fig. 33.—Mycetoma, or Madura Foot.

(Museum of Royal College of Surgeons, Edinburgh.)

patch, which becomes discoloured and permeated by black or yellow nodules containing the organism. These nodules spread through the foot, break down by suppuration, and numerous minute abscesses lined by granulation tissue are thus formed. In the pus are found yellow particles likened to fish-roe, or black pigmented granules like gunpowder. Sinuses form, and the whole foot becomes greatly swollen and distorted by flattening of the sole and dorsiflexion of the toes. Areas of caries or necrosis occur in the bones of the foot (Fig. 33); and the disease gradually extends up the leg. There is but little pain, and no glandular involvement or constitutional disturbance. The disease runs a prolonged course, sometimes lasting for twenty or thirty years. Spontaneous cure never takes place, and the risk to life is that of prolonged suppuration.

If the disease is localised it may be removed by the knife or sharp spoon, and the part afterwards cauterised. As a rule, amputation well above the disease is the best line of treatment. Unlike actinomycosis, this disease does not appear to be benefited by iodides.

Delhi Boil.—*Synonyms*—Aleppo boil, Biskra button, Furunculus orientalis, Natal sore.

Delhi boil is a chronic inflammatory disease, most commonly met with in India, especially towards the end of the wet season. The disease

occurs oftenest on the face, and is believed to be due to an organism, although this has not been demonstrated. The infection is supposed to be conveyed through water used for washing, or by the bites of insects.

*Clinical Features.*—A red spot, resembling the mark of a mosquito bite, appears on the affected part, and is attended with itching. After becoming papular and increasing to the size of a pea, desquamation takes place, leaving a dull-red surface over which in the course of several weeks there develops a series of small yellowish-white spots, from which serum exudes, and, drying, forms a thick scab. Under this scab the skin ulcerates, leaving small oval sores with sharply bevelled edges, and an uneven floor covered with yellow or sanious pus. These sores vary in number from one to forty or fifty. They may last for months and then heal spontaneously, or may continue to spread until arrested by suitable treatment. There is no enlargement of adjacent glands, and but little inflammatory reaction in the surrounding tissues; nor is there any marked constitutional disturbance. Recovery is often followed by considerable cicatricial contraction leading to marked deformity of the face.

The *treatment* consists in destroying the original papule by the actual cautery, acid nitrate of mercury, or pure carbolic acid. The ulcers should be scraped with the sharp spoon, and cauterised.

Chigoe.—Chigoe or jigger results from the introduction of the eggs of the sand-flea (*Pulex penetrans*) into the tissues. It occurs in tropical Africa, South America, and the West Indies. The impregnated female flea remains attached to the part till the eggs mature, when by their irritation they cause localised inflammation with pustular or vesicular swelling. Children are most commonly attacked, particularly about the toe-nails and on the scrotum. The treatment consists in picking out the insect with a blunt needle, special care being taken not to break it up. The puncture is then canterised. The application of essential oils to the feet acts as a preventive.

Poisoning by Insects.—The bites of certain insects, such as mosquitoes, midges, different varieties of flies, wasps, and spiders, may be followed by serious complications. The effects are mainly due to the injection of an irritant acid secretion, the exact nature of which has not been ascertained.

The local lesion is a puncture, surrounded by a zone of hyperæmia, wheals, or vesicles, and is associated with burning sensations and itching, which usually pass off in a few hours, but may recur at intervals, especially when the patient is warm in bed. Scratching also reproduces the local signs and symptoms. Where the connective tissue is loose—for example, in the eyelid or scrotum—there is often considerable swelling; and in the mouth and fauces this may lead to œdema of the glottis, which may prove fatal.

The *treatment* consists in the local application of dilute alkalies such as ammonia water, solutions of carbonate or bicarbonate of soda, or sal-volatile. Weak carbolic lotions, or lead and opium lotion, are useful in allaying the local irritation. One of the best means of neutralising the poison is to apply to the sting a drop of a mixture containing equal parts of pure carbolic acid and ammonia.

Free stimulation is called for when severe constitutional symptoms are present.

Snake-Bites.—We are here only concerned with the injuries inflicted by the venomous varieties of snakes, the most important of which are the hooded snakes of India, the rattlesnakes of America, the horned

snakes of Africa, the viper of Europe, and the adder of the United Kingdom.

While the virulence of these creatures varies widely, they are all capable of producing in a greater or less degree symptoms of acute poisoning in man and other animals. By means of two recurved fangs attached to the upper jaw, and connected by a duct with poison-secreting glands, they introduce into their prey a thick, transparent, yellowish fluid, of acid reaction, probably of the nature of an albumose, and known as the *venom*.

The *clinical features* resulting from the injection of the venom vary directly in intensity with the amount of the poison introduced, and the rapidity with which it reaches the circulating blood, being most marked when it immediately enters a large vein. The poison is innocuous when taken into the stomach.

*Locally* the snake inflicts a double wound, passing vertically into the subcutaneous tissue; the edges of the punctures are ecchymosed, and the adjacent vessels the seat of thrombosis. Immediately there is intense pain, and considerable swelling with congestion, which tends to spread towards the trunk. Extensive gangrene may ensue. There is no special involvement of the lymphatics.

The *general symptoms* may come on at once if the snake be a particularly venomous one, or not for some hours if less virulent. In the majority of viper or adder bites the general constitutional disturbance is slight and transient, if it appears at all. Snake-bites in children are particularly dangerous.

The patient's condition is one of profound shock with faintness, giddiness, dimness of sight, and probably loss of speech, and a feeling of great terror. The pupils dilate, the skin becomes moist with a clammy sweat, and nausea with vomiting, sometimes of blood, ensues. High fever, cramps, loss of sensation, hæmaturia, and melæna are among the other symptoms which may be present. The pulse becomes feeble and rapid, the respiratory nerve centres are profoundly depressed, and delirium followed by coma usually precedes the fatal issue, which may take place in from five to forty-eight hours. If the patient survives for two days the prognosis is favourable.

*Treatment.*—A broad ligature should be tied tightly round the limb just above the seat of infection to prevent the poison passing into the general circulation. Bleeding from the wound should be encouraged, and, if necessary, incisions may be made for this purpose. The application of an Esmarch's elastic bandage from above downward to empty the blood out of the infected portion of the limb has been recommended. The whole of the bite should at once be excised, and the raw surface treated with a solution of permanganate of potash or peroxide of hydrogen, which destroys the poison by oxidation.

The general treatment consists in free stimulation with whisky, brandy, ammonia, digitalis, etc. Hypodermic injections of strychnine in doses sufficiently large to produce a slight degree of poisoning by the drug are particularly useful. The most rational treatment, when it is available, is the use of the *antivenin* introduced by Fraser and Calmette.

# CHAPTER IX.

## TUBERCULOSIS.

Definition of tuberculous disease—Tubercle bacilli—Methods of infection—Inherited and acquired predisposition—Action of the bacillus upon the tissues—Tuberculous granulation tissue—Natural cure—Recrudescence of the disease—The Tuberculous Abscess—Contents and wall of the abscess.

The term tuberculosis is applied generically to the various pathological conditions which result from the action of the tubercle bacillus. The diseases produced by this organism are spoken of as *tuberculous*, and as this term indicates the essential nature of the affection, it is to be preferred to the terms "strumous" and "scrofulous" previously employed.

Tuberculosis may be met with in any of the tissues or organs of the body, but it occurs more frequently in some situations than in others. It is very common, for example, in lymphatic glands, in bones and joints, in the peritoneum, the intestine, the kidney, prostate and testis, and in the skin and subcutaneous cellular tissue. It is seldom met with in the breast or in muscles, and it rarely affects the ovary, the pancreas, the parotid, or the thyroid.

*Tubercle bacilli* occur as straight or slightly curved rods, measuring about 3 $\mu$ by ·3 $\mu$ (Fig. 34). They have no power of movement. It is as yet undecided whether or not they form spores. Their virulence varies widely, and they are more tenacious of life than the common pyogenic bacteria. In a dry state, for example, they can retain their vitality for months; and they can also survive immersion in water for prolonged periods. They resist the action of the products of putrefaction for a considerable time, and are not destroyed by digestive processes in the stomach and intestine. They may be killed in a few minutes by immersion in 1 in 20 carbolic lotion, by boiling, or by exposure to steam under pressure.

"The great multiplying ground of tubercle bacilli is the animal body, and tuberculous tissues and secretions containing the bacilli are the chief, if not the only means by which the disease is spread. The bacilli leave the body in large numbers in the sputum of phthisical patients, and when the sputum becomes dried and pulverised they are set free in the air. Their presence in the air of rooms containing consumptive patients has been repeatedly demonstrated. So far as the

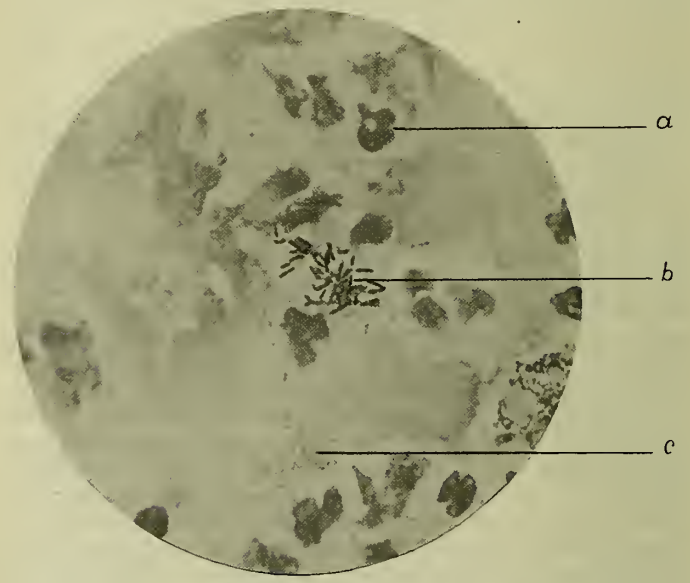



FIG. 34.—Tubercle bacilli in Pus from Urine in case of genito-urinary tuberculosis. ×1000 diam.

*a*=Pus cell. *b*=Clump of tubercle bacilli.
*c*=Small bacilli—probably B. urea.

human subject is concerned, the great means of disseminating the bacilli in the outer world is dried phthisical sputum. Another possible source of infection, especially in children, is the milk of cows affected with tuberculosis of the udder."[1]

In marked contrast to what obtains in the infective diseases which have already been described, tuberculosis rarely results from the infection of a wound on the external surface of the body. In exceptional instances, however, this does occur, and

[1] Muir and Ritchie, *Manual of Bacteriology*, 3rd edition, 1902.

in illustration of the fact may be cited the case of a servant girl who cut her finger with a broken spittoon containing the sputum of her consumptive master; the wound subsequently showed evidence of tuberculous infection, which ultimately spread up along the lymphatic vessels of the arm. Pathologists, too, whose hands, unless they are protected by rubber gloves, are frequently exposed to the contact of tuberculous tissues and pus, are liable to suffer from a form of tuberculosis of the skin of the finger, known as *anatomical tubercle*. Slight wounds of the feet in children who go about barefoot in towns sometimes become infected with tubercle. Operation wounds made with instruments contaminated with tuberculous material have also been known to become infected. It is highly probable that the common form of tuberculosis of the skin known as "lupus" arises by direct infection from without.

In the vast majority of cases the tubercle bacillus gains entrance to the body by way of the internal mucous surfaces, the organisms being either inhaled or swallowed.

*The respiratory mucous membrane*, from the nose and mouth to the terminations of the air-tubes in the lungs, is constantly exposed to infection by the inhalation of air laden with dust and other minute particles to which the virus is adherent. The existence of inflammation, or of some superficial lesion of these mucous surfaces, favours the entrance of the bacilli into the tissues, whence they pass by way of the lymphatic vessels to the glands. The glands most frequently infected in this way are the cervical glands, and those within the cavity of the chest —particularly the bronchial glands at the root of the lung.

The entrance of the bacilli into one or other of these groups of glands may result in active tuberculous disease of the infected group. On the other hand, there is reason to believe that the organisms may lie in a dormant or latent condition for an almost indefinite period, and only become active long afterwards, when some general depression of the patient's health produces conditions which favour their growth. When the organisms become active in this way, the tuberculous tissue may undergo softening and disintegration, the infective material may erupt into an adjacent vein, and thus entering the general circulation, may be carried by the blood-stream to distant parts of the body, and so give rise either to a localised tuberculosis elsewhere or to a general tuberculosis. The initial infection of the lymphatic glands within the chest, being unattended with any external or clinical evidence of its occurrence, remains unrecognised and unsuspected, and the patient, usually

a child, may present the appearances of even robust health. At any subsequent period of life, however, tuberculous disease may make its appearance in some tissue of the body—for example, in a bone or joint, in the kidney or testicle, or in the membranes of the brain. More than one tissue may be infected either simultaneously or in succession, without any external evidence of the transference of the bacilli from one part of the body to another. Many tuberculous patients are to be regarded as possessing in their bronchial glands, or elsewhere, an internal store of bacilli, to which the existing disease owes its origin, and from which similar outbreaks of tuberculosis may originate in the future.

It is probable that in some cases the tubercle bacilli may effect an entrance through the mucous membrane of the respiratory tract directly into the blood-vessels, and thus into the circulating blood, by means of which they may be carried to any part of the body.

*The alimentary mucous membrane*, especially that of the small intestine, is exposed to infection by swallowed sputum and by food materials, such as milk, containing tubercle bacilli. The organisms may lodge in the mucous membrane and cause tuberculous ulceration, or they may be carried through the wall of the bowel into the lacteals, along which they pass to the mesenteric glands. There they may become arrested and give rise to tuberculous disease of the glands; or they may either become active at a subsequent period, or may lie dormant indefinitely. It may happen that the bacilli from a tuberculous mesenteric gland are carried by way of the receptacle of the chyle and the thoracic duct into the general circulation, and in this way infect distant parts of the body, or give rise to general tuberculosis. In some cases the transference of the infective material is more direct—for example, when a softened mesenteric gland erupts into a contiguous vein and so infects the circulating blood, or erupts on to the peritoneum covering the mesentery and sets up a tuberculous peritonitis.

**Predisposition to Tuberculosis.**—That some individuals are more prone to become the subjects of tuberculosis than others is evident from the fact that while under the existing conditions of civilised life all are exposed to the infection, only a comparatively small number acquire the disease. The precise conditions which favour the entrance, lodgment, and growth of the bacilli in those predisposed to the disease are somewhat uncertain. It may be that there is some peculiarity of the tissues which renders them a specially suitable soil for the organisms, or that

the patient's power of resisting the invasion of the virus is abnormally low. In any case, with regard to the etiology of tuberculosis, this predisposition is to be looked upon as a factor second in importance only to the presence of the bacilli themselves. In some cases the predisposition is inherited, in others it is acquired.

Those who *inherit* the predisposition usually belong to families in which the disease is specially rife, and although as children they may have all the appearance of being healthy and even robust, if exposed to infection they are much more liable to contract tuberculosis than are members of families in which the disease is unknown. The inherited predisposition dates from the commencement of life, and only terminates with it. Children are very seldom born with tuberculous lesions, and in the recorded cases of congenital tuberculosis there has almost always been tuberculous disease in the placenta.

There is abundant evidence that the common diseases of infancy and childhood,—such, for example, as whooping-cough, measles, influenza, bronchial catarrh, broncho-pneumonia, and rickets,—by impairing the general health and lowering the resisting powers of the individual, exert an important influence in producing an *acquired* predisposition to tuberculosis. Tuberculous affections frequently date from an attack of one or other of these illnesses, the inflamed and catarrhal condition of the respiratory and other mucous membranes doubtless favouring the occurrence of tuberculous infection. Confinement in crowded dwellings, schoolrooms, workshops, and factories is also injurious, as it entails the breathing of impure air which may be contaminated with tubercle bacilli. Insufficient and improper feeding, by lowering the general vitality and by leading to impairment of digestion and catarrhal changes in the alimentary mucous membranes, has also a prejudicial influence.

In practice it is not uncommon to meet with a combination of the above-mentioned predisposing factors, all conspiring to render the soil more favourable to the growth of tubercle.

Any tissue whose vitality has been lowered by injury or disease furnishes a favourable nidus for the lodgment and growth of tubercle bacilli. The injury or disease, however, is to be looked upon as determining the localisation of the tuberculous lesion rather than as an essential factor in its causation. In a person, for example, in whose blood tubercle bacilli are circulating and reaching every tissue and organ of the body, the occurrence of tuberculous disease in a particular part may be

determined by the depression of the tissues resulting from an injury of that part.

Statistics show that the largest number of cases of surgical tuberculosis are met with between the ages of five and fifteen. At the same time, this apparent excessive frequency during the early years of life is partly accounted for by the correspondingly larger number of individuals alive during these years. Stated in another way, tuberculosis may be comparatively rare above the age of seventy, but so are people. It must be emphasised that tuberculosis may be met with at any period of life; the mere fact that a patient is up in years is not a sufficient reason for excluding the possibility of a given lesion being tuberculous. In children and young adults surgical tuberculosis is not only pre-eminently curable, but shows a marked tendency towards spontaneous recovery if the patient is placed under favourable conditions. The reparative process is an exceedingly slow one, and the treatment demands patience and perseverance alike from the patient and from the surgeon. In patients past the prime of life, however, there is little tendency to natural recovery from tuberculous affections, and small prospect of any but the most radical operations effecting a cure of the disease.

While it is a fact that males are, on the whole, more often affected than females, the influence of sex in predisposing to tuberculosis is not certain.

**Changes in the Tissues following upon the successful Lodgment of Tubercle Bacilli.**—The action of the bacillus on the tissues is twofold: on the one hand, by its irritation it induces tissue reaction in the form of proliferative changes and leucocyte infiltration; and, on the other, it causes in the cells around degenerative changes which ultimately result in their death.

The area of tissue infected becomes the seat of a chronic inflammation, attended with the formation of a friable, gelatinous granulation tissue. This may be collected into circumscribed nodules or "tubercles," or it may be ill-defined, diffuse, and infiltrating. This granulation tissue presents characteristic histological elements—for example, large cells, often with more than one nucleus, spoken of as *endothelioid cells*; and still larger cells, known as *giant cells*. There are also large numbers of *small round cells* which resemble the leucocytes of the blood and lymph. It is further characteristic of tuberculous granulation tissue that it tends to undergo certain forms of degeneration and death, of which the best known is

*caseation.* This implies the conversion of the tissue into an amorphous, pale-yellow or whitish material resembling cheese. Lime salts may subsequently be deposited in this material—a change known as *calcification.*

The recognition of the characteristic elements above described, with or without caseation, is usually sufficient evidence of the tuberculous nature of any portion of tissue examined for diagnostic purposes. The recognition of the bacillus itself by appropriate methods of staining makes the diagnosis a certainty; but as it is by no means easy to identify the organism in many forms of surgical tuberculosis, it may be necessary to have recourse to experimental inoculation.

The changes subsequent to the formation of tuberculous granulation tissue are liable to many variations. It must always be borne in mind that although the bacilli have effected a lodgment and have inaugurated disease, the relation between them and the tissues remains one of mutual antagonism; which of them is to gain and keep the upper hand in the conflict depends on their relative powers of resistance.

If the tissues prevail, there ensues a process of repair. In the immediate vicinity of the area of infection young connective tissue, and later, fibrous tissue, is formed. This may entirely replace the tuberculous tissue and bring about repair—a fibrous cicatrix remaining to mark the scene of the previous contest. Scars of this nature are not infrequently discovered at the apex of the lung after death in patients who have at one time suffered from pulmonary phthisis. Under other circumstances the tuberculous tissue which has undergone caseation, or even calcification, is only encapsulated by the new fibrous tissue, like a foreign body. Although this may be regarded as a victory for the tissues, the cure, if such it may be called, is not necessarily a permanent one, for at any subsequent period of life, if the part affected is disturbed by injury or through some other influence, the encapsulated tubercle may again become active and get the upper hand of the tissues, and there results a relapse or recrudescence of the disease.

If, however, at the inauguration of the tuberculous disease the bacilli prevail, the infection tends to spread into the tissues surrounding those originally infected, and more and more tuberculous granulation tissue is formed. Finally the tuberculous tissue breaks down and liquefies, resulting in the formation of a cold abscess. In their struggle with the tissues, tubercle bacilli receive considerable support and assistance from any pyogenic organisms which may be present. A tuberculous

infection may exhibit its aggressive qualities in a more serious manner by sending off detachments of bacilli, which are carried by the lymphatics to the nearest glands, or by the blood-stream to more distant, and it may be to all, parts of the body. When the infection is thus generalised, the condition is called *general tuberculosis*. Considering the extraordinary frequency of localised forms of surgical tuberculosis, general dissemination of the disease is very rare.

**The clinical features** of surgical tuberculosis vary with the situation, distribution, and nature of the lesion. The onset of the disease is usually attended with impairment of the general health and vigour. It is commonly observed that the patient has been losing flesh and is not taking the usual quantity of food. The more advanced symptoms—fever, sweating, and emaciation—are to be ascribed to the absorption and distribution throughout the system of the toxic products, not only of the tubercle bacilli, but also of other, and especially of pyogenic organisms, with which, in its later stages, the tuberculous infection is often complicated.

**The general treatment** consists in combating the adverse influences which have been mentioned as increasing the liability to tuberculous infection. Within recent years the value of the "open-air" treatment has been widely recognised. An open-air life, even in the centre of a city, may be followed by marked improvement, especially in the hospital class of patient, whose home surroundings tend to favour the progress of tuberculous disease. The purer air of places away from centres of population is still better; and, according to the idiosyncrasies of the individual patient, mountain air or that on the sea-coast may be preferred. In view of the possible discomforts and gastric disturbance which may attend a sea-voyage, this should be recommended to patients suffering from tuberculous lesions with more caution than has hitherto been exercised. The diet must be a liberal one, and should include those articles which are at the same time easily digested and nourishing, especially proteids and fats; milk obtained from a reliable source, and underdone meat are among the best. When the ordinary nourishment taken is insufficient, it may be supplemented by such articles as malt extract, stout, and cod-liver oil. The last is specially beneficial in patients who do not take enough fat in other forms. It is noteworthy that many tuberculous patients show an aversion to fat. Cod-liver oil should be given in small quantities until the patient becomes accustomed to it. When the oil in the pure state continues

to be distasteful or to disagree, one or other of the emulsified forms may be substituted. The general health may be benefited by the administration of tonics—such, for example, as the syrup of the iodide of iron.

While in many instances we trust to the *vis medicatrix naturæ* aided by measures calculated to improve the general health, in others, steps are taken which are intended to increase the vitality of the tissues and to help them to gain the upper hand in their conflict with the bacilli. The chief of these are the use of iodoform, the artificial production of venous congestion, and the application of various rays.

*Iodoform*, which was first employed in tuberculous lesions by Mosetig Moorhof, of Vienna, appears to act by irritating the tissues and stimulating the formation of granulation tissue, whereby the focus of tuberculous infection is either destroyed or encapsulated. Iodoform is employed in various ways: gauze or worsted impregnated with the powder is used to pack tuberculous cavities and sinuses; dissolved in ether or suspended in glycerin, it is injected into the tissues or into a closed cavity such as a joint or an abscess. Experience has shown that it acts more efficiently upon the tuberculous infection in a cavity shut off from the air; this may be due to the liberation of iodine as already indicated (p. 33). Durante, of Rome, has obtained good results by injecting iodine, dissolved in a solution of iodide of potassium, and Lannelongue, of Paris, injects a five per cent. solution of chloride of zinc into the tissues surrounding the tuberculous focus.

The artificial production of *venous congestion* was introduced by Bier, of Bonn, in imitation of the resistance offered to tuberculous infection by the lungs when they are the seat of chronic venous congestion. It would appear that intermittent venous congestion stimulates the formation of granulation and cicatricial tissue. In the case of a limb, the segment below the lesion is supported by a firmly applied bandage, while above the lesion a few turns of an elastic bandage are applied so as to compress the veins and bring about a cyanosed condition of the tissues that are the seat of tubercle. The congestion is maintained for from three to eight hours daily over a period of at least three months. The method has been chiefly used in tuberculous disease in joints, in tendon sheaths, and in the testicle.

*Treatment by Rays.*—On the basis that sunlight is inimical to the growth of certain forms of bacterial life, Finsen, of Copenhagen, introduced the treatment of tuberculous disease of

the skin by concentrating the rays of the sun on the affected part by means of lenses. When sun-rays are not available, the rays from a powerful arc light are substituted. The beneficial influence would appear to depend, in part, on the reactive changes excited in the tissues as evidenced by their increased vascularity and subsequent desquamation of the skin. The use of sunlight and electric light has been to a large extent superseded by the Röntgen rays and by those given off by radium.

In many instances a more rapid cure of the disease may be attained by *operative interference*. Complete extirpation of the infected tissues is practicable, for instance, in lymphatic glands, kidney, or testis; when this is impracticable and the removal of the tuberculous tissue by scissors and sharp spoon is necessarily incomplete, the raw surface which is left is rubbed with iodoform or cauterised by the hot iron or pure carbolic acid.

### Tuberculous Abscess.

The caseation of tuberculous granulation tissue and its liquefaction into pus is a slow and insidious process, and is unattended with the classical signs of inflammation—hence the terms "cold" and "chronic" applied to the tuberculous abscess.

In a typical cold abscess, such as that which results from tuberculous disease of the vertebræ, the clinical appearances are those of a soft, fluid swelling without heat, redness, pain, or fever. When inflammatory symptoms are present they are usually due to a mixed infection with ordinary pyogenic bacteria having taken place.

A tuberculous abscess results from the disintegration and liquefaction of tuberculous granulation tissue which has undergone caseation. Fluid and cells from the adjacent blood-vessels exude into the cavity, and lead to variations in the character of its contents. In some cases the contents consist of a clear amber-coloured fluid, in which are suspended flakes or fragments of broken-down caseated tissue; in others, of a thick, white material like cream-cheese. From the addition of a large number of emigrated leucocytes, the contents may closely resemble the pus of an ordinary abscess.

The wall of the abscess is lined with tuberculous granulation tissue, the inner layers of which are undergoing caseation and disintegration and present a shreddy appearance; the outer layers consist of tuberculous tissue which has not yet undergone caseation. The abscess tends to increase in size by progressive

liquefaction of the inner layers, caseation of the outer layers, and the further invasion of the surrounding tissues by tubercle bacilli. In this way a tuberculous abscess is capable of indefinite extension and increase in size until it reaches a free surface and ruptures externally. Once a collection of tuberculous pus has formed, the direction in which it spreads is influenced by the anatomical arrangement of the tissues, and possibly to some extent by gravity, and the abscess may come to the surface at a considerable distance from its seat of origin. The best illustration of this is seen in psoas abscess, which may originate in the dorsal vertebræ, extend downwards within the sheath of the psoas muscle, and finally appear in the thigh.

*Clinical Features.*—The slow and insidious development of the tuberculous abscess is one of its most characteristic features. The swelling may attain a considerable size without the patient being aware of its existence, and, as a matter of fact, it is often discovered accidentally. There is an absence of the ordinary signs of inflammation; but if the patient is under observation, and a record kept of the daily temperature, a slight rise may be noted in the evening during the development and progress of the abscess. There is frequently a quiescent stage of the tuberculous abscess, which is not attended with any rise of temperature. According to its situation and mode of origin, the abscess varies in size from a small cherry to a cavity containing several pints of pus. The shape of the abscess varies; it is usually that of a flattened sphere, but it may present pockets or burrows running in various directions. Sometimes the abscess is hour-glass or dumb-bell shaped; this is well illustrated in the region of the groin in disease of the spine or pelvis, where there may be one large sac occupying the venter ilii, and a smaller one in the thigh, the two communicating by a narrow channel under Poupart's ligament. By pressing with the fingers the pus may be displaced from one compartment to the other. Occasionally the progress of the abscess is arrested, and it may remain stationary for an indefinite period. The usual course of events, however, is that the abscess progresses slowly, and finally reaches a free surface—usually the skin. As it does so there may be some pain, redness, and local elevation of temperature. Fluctuation becomes more and more evident and superficial, and the skin becomes livid and finally gives way. If the case is left to nature, the discharge of pus continues, and the track opening on the skin surface remains as *a sinus*. The persistence of suppuration is due to the presence in the wall of the abscess and of the sinus, of tubercle bacilli and tuberculous granulation tissue,

which, so long as they remain, continue to furnish discharge, and so prevent healing. Sooner or later pyogenic organisms gain access to the sinus, and through it to the wall of the abscess. They tend further to depress the resisting power of the tissues, and thereby aggravate and perpetuate the tuberculous disease. This superadded infection with pyogenic organisms exposes the patient to the further risks of septic intoxication, especially in the form of hectic fever and septicæmia, and increases the liability to general tuberculosis. A tuberculous abscess may in one or other of these ways be a cause of death.

A chronic abscess may be met with anywhere in the subcutaneous or other cellular tissue. It is often the result of tuberculous disease in a lymphatic gland, in a bone, or in one or other of the organs of the body, such as the kidney or testicle.

*Residual abscess* is the name given to an abscess which may make its appearance months, or even years, after the apparent cure of tuberculous disease—as, for example, in the hip-joint or spine. It is called residual because it has its origin in the residuum or remains of the original disease.

*Diagnosis.*—A cold abscess in the quiescent stage is to be diagnosed from a softening syphilitic gumma, a cyst, a lipoma, and from other soft tumours. The differential diagnosis of these affections will be considered later. When a tuberculous abscess is about to burst externally, it may be difficult to distinguish it from an abscess due to infection with pyogenic organisms. Help is obtained by the history, and by recognising the association of the abscess with tuberculous disease in one of the organs or tissues in the neighbourhood. Even when the abscess is opened, the appearances of the pus may not supply the desired information, and it may be necessary to submit it to bacteriological examination. When no organisms are found in the pus it is usually safe to assume that the condition is tuberculous. Experimental inoculation may enable us to arrive at an accurate diagnosis, but it implies a delay of two to three weeks.

*Treatment.*—It is instructive to know that before the introduction of Listerian methods, surgeons deprecated the opening of tuberculous abscesses because of the almost inevitable occurrence of pyogenic infection, and of the risks which this implies. After the introduction of antiseptics, it became possible to open such abscesses without these risks, and the procedure employed was to make an opening in a dependent position, and secure drainage by means of a rubber tube. The usual result was that the abscess continued to discharge, often for long periods, and the track of the tube frequently became a persistent

sinus. The aim of the present methods of treatment is to destroy the tuberculous tissue in the wall of the abscess, for in it is contained the tuberculous infection which is the cause both of the abscess and of the persistence of discharge after it has been opened. This is carried out in various ways, according to the situation and extent of the abscess.

We shall consider in the first place the various procedures employed when the skin over the abscess is intact. Theoretically the most certain measure is to *excise the abscess as a whole*, as if it were a tumour; but in practice this is seldom possible except in the small subcutaneous abscesses or strumous nodes met with in children.

*Evacuation of the Abscess and Injection of Iodoform.*—The iodoform is employed in the form of a ten per cent. solution in ether or the same proportion suspended in glycerin. Either form becomes sterile soon after it is prepared. Its curative effects would appear to depend upon the liberation of iodine, which restrains the activity of the bacilli, and upon its capacity for irritating the tissues and so inducing a protective leucocytosis, and also of stimulating the formation of scar tissue. An anæsthetic is rarely called for, except in children. The abscess is first evacuated by means of a large trocar and cannula introduced obliquely through the overlying soft parts, avoiding any part where the skin is thin or red. If the cannula becomes blocked with caseous material it must be cleared with a probe. The iodoform is injected by means of a glass-barrelled syringe, which should be firmly screwed on to the cannula. The amount injected varies with the size of the abscess and the age of the patient; it may be said to range from two or three drams in the case of children to several ounces in larger abscesses in adults. The cannula is then withdrawn, and the puncture covered with a gauze dressing, and bandaged so as to exert a certain amount of compression. If the abscess fills up again, the procedure should be repeated.

When the contents of the abscess are semi-solid and cannot be withdrawn even through a large cannula, a small incision must be made, and, after emptying the cavity, the iodoform is introduced through a short rubber tube attached to the syringe. The injection is continued while the wound is being closed with sutures, so that when the operation is completed the cavity will be distended with the fluid. The method is only satisfactory if the wound heals by first intention. Experience has shown that even large abscesses, such as those associated with spinal disease, may be cured by iodoform injection.

Another method of treatment which is only applicable in abscesses of moderate size is by *incision of the abscess and removal of the tuberculous tissue in its wall* with the sharp spoon. An incision is made which will give free access to the interior of the abscess, so that outlying pockets or recesses may not be overlooked. Small incisions are only justifiable when an extensive scar would be disfiguring. After removal of the pus, the walls of the abscess are thoroughly scraped with the ordinary Volkmann spoon or with Barker's flushing spoon, to get rid of the tuberculous granulation tissue with which they are lined. In using the spoon care must be taken that its sharp edge does not perforate the wall of a vein or other important structure. Any debris which may adhere to the walls is removed by rubbing with dry gauze. The oozing of blood from the raw surface left after scraping is arrested by packing the cavity for a few minutes with gauze. After the packing is removed, the walls are painted with pure carbolic acid, and iodoform powder is rubbed into the raw surface. If the abscess is so situated that its cavity can be obliterated by pressure, and if there is no suspicion of septic infection, the wound may be stitched up. If, on the other hand, there is fear of a mixed infection, it is safer to treat it by the open method, packing the cavity with iodoform worsted, which is renewed at intervals as the cavity heals from the bottom.

When the skin over the abscess is red, thin, and about to give way, as is frequently the case when the abscess is situated in the subcutaneous cellular tissue, any portion of skin which is undermined and infected with tubercle should be removed with the scissors at the same time that the abscess is incised.

In abscesses treated by the open method, when the cavity has become lined with healthy granulations, it may be closed by secondary sutures, or, if the granulating surface is flush with the skin, healing may be hastened by skin-grafting.

If the tuberculous abscess does not come under treatment until after it has burst and left a sinus, the treatment varies with its situation and extent; sinuses in accessible situations should be excised or laid open, scraped, and made to heal from the bottom by the open method; more deeply placed and extensive sinuses, such as result from the bursting of a psoas abscess, do not lend themselves to such treatment. An attempt may be made to pack them with iodoform gauze or with gauze wrung out of pure carbolic acid.

We have observed benefit in such sinuses from the daily application of the X-rays.

In the treatment of a tuberculous abscess it is always necessary to search for any associated disease such as may be found in a lymphatic gland or bone, and to this, treatment must also be directed.

The *tuberculous ulcer* has been described in the chapter on Ulcers, page 78, and the *tuberculous sinus* on page 64.

# CHAPTER X.

## SYPHILIS.

Definition.—Virus.—Acquired Syphilis—Primary period: *Incubation, primary chancre, glandular enlargement, extra-genital chancres*—Treatment—Secondary period: *General symptoms, skin affections, mucous patches, affections of bones, joints, eyes, etc.*—Treatment: *Methods of administering mercury*—Syphilis and marriage—Intermediate stage—*Reminders*—Tertiary period: *General symptoms, gummata, tertiary ulcers, tertiary lesions of skin, mucous membrane, bones, joints, etc.*—Second attacks.—Inherited Syphilis—Transmission—*Clinical features in infancy, in later life*—Contagiousness—Treatment.

Syphilis is an infective disease due to the entrance into the body of a specific virus; it is nearly always communicated from one individual to another by contact infection, the discharge from a syphilitic lesion being the medium through which the virus is transmitted.

It belongs to the group of diseases known as the infective granulomata, a group which includes tuberculosis, actinomycosis, glanders, and leprosy. Syphilis may be described as a chronic inflammation attended with the formation of granulation tissue which has certain structural peculiarities and degenerative tendencies. Syphilitic granulation tissue is made up of round cells, epithelioid cells, and giant cells, so like those met with in tuberculous lesions that a differential diagnosis based on histological structure alone cannot be relied upon. It may be possible, however, to distinguish tuberculous from syphilitic granulation tissue by demonstrating tubercle bacilli in the former.

When syphilis is communicated from one individual to another by contact infection, the condition is spoken of as acquired syphilis, and the first visible sign of the disease appears at the site of inoculation, and is known as *the primary lesion.* Those who have thus acquired the disease may transmit it to their offspring, who are then said to suffer from *inherited syphilis.*

**The Virus of Syphilis.**—In the other diseases belonging to the group of infective granulomata, the nature of the infective agent has for some time been definitely established, but in the case of syphilis, it has until quite recently eluded recognition.

From time to time various micro-organisms have been observed in syphilitic lesions without, however, there being conclusive proof that they represented the true infective agent. The organism, described by Schaudinn and Hoffman in 1905,

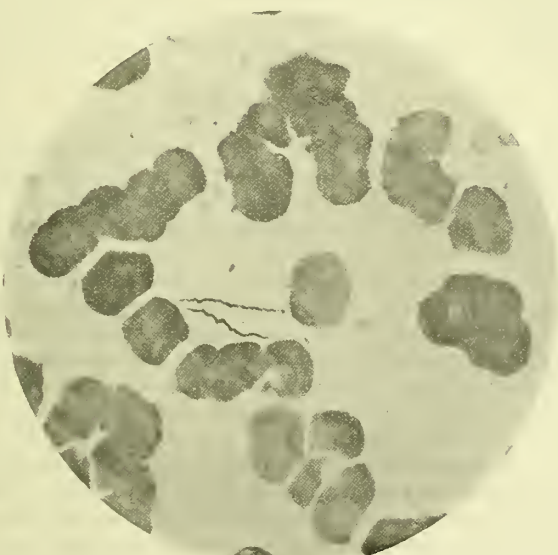


Fig. 35.—Spirochæta pallida. × 1000 diam. Two specimens in centre of field, surrounded by red blood corpuscles.

(From specimen kindly lent by Dr. Theodore Shennan.)

under the name of *spirochæta* (or *spironema*) *pallida*, has been identified by so many observers in the lesions both of acquired and of inherited syphilis that there appear to be sufficient grounds for regarding it as the cause of the disease. The spirochæta (Fig. 35) is a delicate thread-like organism presenting several spiral turns and pointed ends; it is markedly mobile, and is stained with difficulty. It varies in length from 4-10 $\mu$, and in width measures about ·25 $\mu$. It is readily destroyed by heat. No one has as yet succeeded in cultivating it. It may

be recognised in films obtained by scraping the primary lesion, or from secondary lesions of the skin and mouth. It is of importance that it is found also in non-ulcerated lesions, such as papules and buboes away from the primary sore; in the circulating and splenic blood in acquired syphilis; and in the blood and internal organs in the inherited form of the disease. It is absent from tertiary lesions, which, as will be pointed out, are not infective. Considerable interest attaches to the experiments of Metchnikoff and Roux, who have succeeded in conveying syphilis to the chimpanzee, obtaining primary and secondary lesions similar to those observed in man, and also containing the spirochæta.

### Acquired Syphilis.

In the vast majority of cases infection takes place during the congress of the sexes. Delicate, easily abraded surfaces are then brought into contact, and the discharge from lesions containing the virus is placed under favourable conditions for conveying the disease from one person to the other. In the male the possibility of infection taking place is increased if the virus is retained under cover of a long and tight prepuce, and if there are abrasions on the surface with which it comes in contact. The frequency with which infection takes place on the external genitals during sexual intercourse warrants syphilis being considered a venereal disease, although there are other ways in which it may be contracted.

Some of these imply direct contact—such, for example, as kissing, the digital examination of syphilitic patients by doctors or nurses, or infection of the surgeon's fingers while operating upon a syphilitic patient. In suckling, a syphilitic wet nurse may infect a healthy infant, or a syphilitic infant may infect a healthy wet nurse. In other cases the infection is by indirect contact, the virus being conveyed through the medium of articles contaminated by a syphilitic patient—such, for example, as surgical instruments, tobacco pipes, wind instruments, table utensils, towels, or underclothing. Physiological secretions, such as saliva, milk, or tears, are not capable of communicating the disease unless contaminated by discharge from a syphilitic sore. While the saliva itself is innocuous, it can be, and often is, contaminated by the discharge from mucous patches or other syphilitic lesions in the mouth and throat, and is then a dangerous source of infection. Unless these extra-genital sources of infection are borne in mind, there is a danger of failing to recognise the primary sore of syphilis in unusual positions, such

as the lip, finger, or nipple. When the disease is thus acquired by innocent transfer, it is known as *syphilis insontium.*

**Stages or Periods of Syphilis.**—Following the teaching of Ricord, it is customary to subdivide the life-history of syphilis into three periods or stages, referred to, for convenience, as primary, secondary, and tertiary. This subdivision is to some extent arbitrary and artificial, as the different stages overlap one another, and the lesions of one stage merge insensibly into those of another. Wide variations are met with in the manifestations of the secondary stage, and histologically there is no valid distinction to be drawn between secondary and tertiary lesions.

*The primary period* embraces the interval which elapses between the initial infection and the first constitutional manifestations,—roughly from four to eight weeks,—and includes the period of incubation, the development of the primary sore, and the enlargement of the nearest lymphatic glands.

*The secondary period* varies in duration from one to two years, during which time the patient is liable to suffer from manifestations which are for the most part superficial in character, affecting the skin and its appendages, the mucous membranes, and the lymphatic glands.

*The tertiary period* has no time-limit except that it follows upon the secondary, so that during the remainder of his life the patient is liable to suffer from manifestations which may affect the deeper tissues and internal organs as well as the skin and mucous membranes.

**Primary Syphilis.**—*The period of incubation* represents the interval which elapses between the occurrence of infection and the appearance of the primary sore at the site of inoculation. Its limits may be stated as varying from two to six weeks, with an average of from twenty-one to twenty-eight days. While the affection is incubating, there is nothing to show that the patient has contracted any disease.

*The Primary Lesion.*—The incubation period having elapsed, there appears at the site of inoculation a circumscribed area of infiltration which represents the reaction of the tissues to the entrance of the syphilitic virus. The first appearance is that of an indurated sharply defined papule, rarely larger than a split pea. Its surface is at first smooth and shiny, but as necrosis of the tissue elements takes place in the centre, it becomes concave, and in many cases the epithelium is shed and an ulcer is formed. Such an ulcer has an elevated border, sharply cut edges, an indurated base, and exudes a scanty serous discharge; its surface is at first occupied by yellow necrosed tissue, but in

time this is replaced by smooth, pale-pink granulation tissue; finally, epithelium may spread over the surface and the ulcer heals. As a rule the patient suffers little or no discomfort, and may even be ignorant of the existence of the lesion, unless, as a result of exposure to mechanical or septic irritation, ulceration becomes a prominent feature, and it becomes painful and tender, and yields an abundant purulent discharge. The primary lesion, whether ulcerated or not, refuses to disappear under local measures, and persists until the secondary manifestations make their appearance.

It cannot be emphasised too strongly that the induration of the primary lesion, which has obtained for it the name of "hard chancre," is its most important characteristic. It is best appreciated when the sore is grasped from side to side between the finger and thumb. The sensation on grasping it has been aptly compared to that imparted by a nodule of cartilage, or by a button felt through a layer of cloth. The evidence obtained by touch is more valuable than that obtained by inspection, a fact which is made use of in the recognition of *concealed chancres* —that is, those which are hidden from view by a tight prepuce. The induration is due not only to the dense packing of the connective-tissue spaces with leucocytes, but to the formation of new connective-tissue elements. It is most marked in relation to chancres situated in the furrow between the glans and the prepuce.

*In the male*, the primary lesion specially affects certain *situations*, and the appearances vary with these:—(1) On the inner aspect of the prepuce, and in the fold between the prepuce and the glans; in the latter situation the induration imparts a "collar-like" rigidity to the prepuce which is most apparent when it is rolled back over the corona. (2) At the orifice of the prepuce the primary lesion assumes the form of multiple linear ulcers or fissures, and as each of these is attended with infiltration, the prepuce cannot be pulled back—a condition of acquired or syphilitic phimosis. (3) On the glans penis the infiltration may be so superficial that it resembles a layer of parchment, but if it invades the cavernous tissue there is a dense mass of induration. (4) On the external aspect of the prepuce or on the skin of the penis itself. (5) At either end of the torn frænum, in the form of a diamond-shaped ulcer raised above the surroundings. (6) In relation to the meatus and canal of the urethra, in either of which situations the swelling and induration may lead to narrowing of the urethra, so that the urine is passed with pain and difficulty and in a

very minute stream; stricture results only in the exceptional cases in which the chancre has ulcerated and caused destruction of tissue. A chancre within the orifice of the urethra is very rare, and being concealed from view its existence is recognised by the discharge from the meatus and by the induration felt between the finger and thumb.

*In the female*, the primary lesion is not so typical or so easily recognised as in men; it is usually met with on the labia, and the induration is rarely characteristic and does not last so long; sometimes there are several indurated nodules, and according to Arthur Ward the primary lesion may take the form of condylomata.

The hard chancre is usually solitary, but cases are met with in which there are two or more; when there are several, they are individually smaller than the solitary chancre. In all cases of multiple chancre it may be safely assumed that they are the result of simultaneous inoculation of the virus at several points.

It is rather the exception for a hard chancre to leave a visible scar, hence in examining patients with a doubtful history of syphilis, little reliance can be placed on the presence or absence of a scar on the penis. When the primary lesion has taken the form of an open ulcer with purulent discharge, or has sloughed, there is a permanent scar.

*Infection of the adjacent lymphatic glands* is usually found to have taken place by the time the primary lesion has acquired its characteristic induration. Several of the glands along Poupart's ligament, on one or on both sides, become enlarged, rounded, and indurated; they are usually freely movable, and are rarely sensitive unless there is superadded septic infection. The term *bullet-bubo* has been applied to them. Their presence is of value in diagnosis. In a certain number of cases, one of the main lymphatics on the dorsum of the penis is transformed into a fibrous cord easily recognisable on palpation, and when grasped between the fingers appears to be in size and consistence not unlike the vas deferens.

*Concealed chancres* is the term applied when one or more chancres are situated within the sac of a tight prepuce which cannot be retracted. If the induration is well marked they can be palpated through the prepuce, and they are tender on pressure. As under these conditions it is impossible for the patient to keep the parts clean, septic infection becomes a prominent feature, the prepuce is œdematous and inflamed, and there is an abundant discharge of pus from its orifice. It occasionally happens that the septic infection assumes a virulent

character and causes sloughing of the prepuce—a condition known as *phagedæna*. The discharge is then foul and blood-stained, and the prepuce becomes of a dusky red or purple colour and finally slonghs, exposing the glans penis.

*Extra-genital or Erratic Chancres* (Fig. 36).—Erratic chancre is the term applied by Jonathan Hutchinson to the primary lesion of syphilis when it appears on other parts of the body than the genitals. It differs in some respects from the hard chancre as met with on the penis ; it is usually larger, the induration is more diffused, and the enlarged glands are softer and more sensitive. The glands in nearest relation to the sore are those first affected, for example, the epitrochlear or axillary glands in chancre of the finger ; the submaxillary glands in chancre of the lip or mouth ; or of the pre-auricular gland in chancre of the eyelid or forehead. In consequence of their divergence from the typical chancre and of their being often met with in persons who, from age, surroundings, or moral character, are unlikely subjects of venereal disease, the true nature of erratic chancres is often overlooked until the persistence of the lesion, its want of resemblance to anything else, or the onset of constitutional symptoms determines the diagnosis of syphilis. A solitary, indolent sore occurring on the lip, eyelid, finger, or nipple, which does not heal but tends to increase in size, and is associated with induration and enlargement of the adjacent glands, is most likely to be the primary lesion of syphilis.



Fig. 36.—Primary Lesion of Syphilis on knuckle of woman, aet. 51, which was followed by very severe secondary manifestations.

(Mr. A. A. Scot-Skirving's case.)

*The Soft Sore, Soft Chancre, or Chancroid.*—The differential diagnosis of syphilis necessitates the consideration of the *soft sore*, *soft chancre*, or *chancroid*, which is also a common form of venereal disease, and is due to infection with a virulent pus-forming bacillus, first described by Ducrey. Ducrey's bacillus is a short, thick rod which stains readily with any basic aniline dye, but is quickly discoloured by Gramm's method. Its arrangement as a strepto-bacillus in short or long chains is of value in diagnosis. Soft sores are always contracted by direct

contact from another individual, and the incubation period is a short one of from two to five days. The sores are most often situated in the vicinity of the frænum of the prepuce, and, in women, about the labia minora or fourchette; they probably originate in abrasions in these situations. They appear as pustules which are rapidly converted into small, acutely inflamed ulcers which have sharply cut, irregular margins, and yield an abundant yellow purulent discharge. They are devoid of the characteristic induration of syphilis, are painful, and nearly always multiple, reproducing themselves in successive crops by auto-inoculation. Soft sores are frequently complicated with phimosis and balanitis, and they frequently lead to infection of the glands in the groin. The resulting bubo is very different from that associated with syphilis; it is ill-defined, painful, and very tender, and suppuration occurs in about one-fourth of the cases. The overlying skin becomes adherent and red, and suppuration takes place either in the form of separate foci in the interior of the individual glands, or around them; in the latter case on incision the glands are found lying bathed in pus. Ducrey's bacillus is found in a large proportion of the buboes associated with soft sores, and in these the wound, after incision, takes on the characters of a soft sore.

Soft sores heal rapidly when kept thoroughly clean. They should be washed with peroxide of hydrogen, and dusted with an antiseptic powder such as a mixture of one part iodoform and two parts boracic or salicylic acid, or, when the odour of iodoform is objected to, of equal parts of boracic acid and carbonate of zinc. The sore is then covered with a piece of gauze kept in position by drawing the prepuce over it, or by a few turns of a narrow bandage. If the sores spread in spite of this, they should be painted with cocaine and then cauterised. If there is phimosis with balanitis, the prepuce must either be washed out at frequent intervals or removed by circumcision; in the latter case bluestone should be rubbed into the raw surface made at the operation lest it also should take on the characters of a soft sore. When the glands in the groin become inflamed the patient must be confined to bed and a dressing impregnated with ichthyol and glycerin (ten per cent.) applied. When suppuration takes place, the pus must be let out by one or more incisions parallel to Poupart's ligament, any undermined skin cut away, and if the glands are found lying exposed in the abscess cavity they should be enucleated with the sharp spoon. The cavity is lightly packed with iodoform worsted.

*Diagnosis of Primary Syphilis.*—In typical cases where there is a clear history of an incubation period of from three to five weeks since infection, when the sore is indurated, persistent, and indolent, and attended with bullet-buboes in the groin, the diagnosis of primary syphilis is not difficult. It is important to bear in mind *the possibility of a patient having acquired a mixed infection* with the virus of soft chancre, which will manifest itself a few days after infection, and the virus of syphilis, which will show itself after an interval of several weeks. This occurrence was formerly the source of much confusion in diagnosis, and it was believed at one time that syphilis might result from soft sores, but we now know that syphilis does not follow upon soft sores unless the virus of syphilis has been introduced at the same time. The practitioner must be on his guard, therefore, when a patient asks his advice concerning a venereal sore which has appeared within a few days of exposure to infection. Such a patient is naturally anxious to know whether he has contracted syphilis or not, but neither a positive nor a negative answer can be given until the incubation period of syphilis has elapsed—that is, until after an interval of four or five weeks.

Syphilis is also to be diagnosed from epithelioma, the common form of cancer of the penis. It is especially in elderly patients with a tight prepuce that one is liable to mistake the induration of epithelioma for that associated with syphilis. In difficult cases the prepuce must be slit open, or the patient kept under observation until the effects of treatment can be ascertained, as the chancre readily yields to anti-syphilitic remedies.

Difficulty may occur in the diagnosis of primary syphilis from herpes, as this may appear as late as ten days after connection; it commences as a group of vesicles which soon burst and leave shallow ulcers with a yellow floor; these disappear quickly on the use of an antiseptic dusting powder.

Apprehensive patients who have committed sexual indiscretions are apt to regard as syphilitic any lesion which happens to be located on the penis—for example, acne pustules, eczema, psoriasis papules, boils, balanitis, or venereal warts.

*Treatment of Primary Syphilis.*—Reference may be made in the first instance to the question of excising or destroying the primary lesion with a view to preventing general infection. As a matter of fact, this question very rarely arises in practice, because by the time the chancre has sufficiently developed to be diagnosed with certainty, the virus has already entered the lymphatics. When the chancre is situated on the prepuce, however, it may be an advantage to perform circumcision, but

without holding out any certain hope of preventing constitutional infection.

So long as the diagnosis is uncertain, treatment should be restricted to keeping the suspected sore absolutely clean, and to protecting it from irritation. When the diagnosis of syphilis is established, we agree with those who, regarding mercury as the best-known antidote to the virus of syphilis, aim at bringing the patient under the influence of the drug before the disease has become generalised. The methods of administering it will be described with the treatment of secondary syphilis.

*The local treatment* chiefly consists in the maintenance of cleanliness. The part is washed night and morning, preferably with peroxide of hydrogen; if the surface is unbroken, it may be dusted lightly with a powder composed of equal parts of calomel and carbonate of zinc. If there is an ulcer, the traditional and efficient application is a piece of lint or gauze soaked in black wash, renewed night and morning, or oftener if there is much discharge, and kept in place either by drawing the prepuce over it or by a few turns of narrow bandage or plaster. The penis should be supported against the abdominal wall by a triangular handkerchief or bathing-drawers, and if there is inflammatory œdema the patient should be confined to bed.

In *concealed chancres* with phimosis the sac of the prepuce should be frequently washed out, by means of a syringe, with sublimate lotion (1-2000) or peroxide of hydrogen, and the sac packed with a strip of lint soaked in black wash so as to separate the prepuce from the glans. If this does not eliminate the septic element it is better to circumcise the patient and thus obtain free access to the lesion. If phagedæna occurs, the prepuce must be slit open along the dorsum, or if sloughing, cut away, and the patient must sit frequently in a hot bath of weak sublimate lotion. When the chancre is within the meatus, iodoform bougies are inserted into the urethra, and the urine should be rendered bland by drinking large quantities of fluid.

**Secondary Syphilis.**—The following description of secondary syphilis is based on the average course of the disease in patients who are not treated with mercury. The onset of constitutional symptoms occurs from six to twelve weeks after the original infection, and the manifestations are the result of the entrance of the virus into the general circulation, and its being carried to all parts of the body. The period during which the patient is liable to suffer from secondary symptoms varies, but is generally from six months to two years.

In some cases the general health is not disturbed; in others the patient is feverish and out of sorts, losing appetite, becoming pale and anæmic, complaining of lassitude, incapacity for exertion, headache, and pains of a rheumatic type referred to the bones. In isolated cases the temperature rises to 101° or 102° F. and the patient loses flesh. The lymphatic glands accessible to palpation, particularly those along the posterior border of the sterno-mastoid, become enlarged and slightly tender. The hair comes out, eruptions appear on the skin and mucous membranes, and the patient may suffer from sore throat and affections of the eyes.

*Affections of the Skin* are among the most constant manifestations of secondary syphilis. An evanescent macular rash, not unlike that of measles—*roseola*—is the first to appear, usually in from six to eight weeks from the date of infection; it is widely diffused over both aspects of the trunk, and the original dull rose-colour soon fades, leaving brownish stains which in time disappear. It is usually followed by a *papular eruption*, the individual papules being raised above the surface of the skin, smooth or scaly, and as they are due to infiltration of the skin they are more persistent than the roseoles. They vary in size and distribution, being sometimes small, hard, polished, and closely aggregated like lichen, sometimes as large as a shilling-piece, with an accumulation of scales on the surface like that seen in psoriasis. The co-existence of scaly papules and faded roseoles is very suggestive of syphilis.

Other types of eruption are less common than the preceding, and are met with from the third month onwards. A *pustular* eruption, not unlike that of acne or of chicken-pox, is sometimes a prominent feature, but is not characteristic of syphilis unless it affects the scalp and forehead and is associated with the remains of the papular eruption. The term *ichthyma* is applied when the pustules are of large size, and, after breaking on the surface, give rise to superficial ulcers; the discharge from the ulcer often dries up and forms a scab or crust which is continually added to from below as the ulcer extends in area and depth. The term *rupia* is applied when the crusts are prominent, dark in colour, and conical in shape, roughly resembling the shell of a limpet. If the crust is detached, a sharply defined ulcer is exposed, and when this heals it leaves a scar which is usually circular, thin, white, shining like satin, and the surrounding skin is darkly pigmented; in the case of deep ulcers, the scar is depressed and fixed. The student must be prepared to meet with all gradations of skin lesions from papules to punched-out ulcers, and should

regard a combination of the different types as suggestive of syphilis.

In the later stages there may occur a form of creeping or *spreading ulceration of the skin* of the face, groin, or scrotum, healing at one edge and spreading at another very like tuberculous lupus, but distinguished from this by its much more rapid progress and by the pigmentation of the scar.

*Condylomata* are probably more characteristic of syphilis than any other type of skin lesion. They are papules occurring on those parts of the body where the skin is habitually moist, and especially where two skin surfaces are in contact. They are chiefly met with in relation to the external genitals, especially in women, around the anus, beneath large pendulous mammæ, between the toes, and at the angles of the mouth, and in these situations their development is greatly favoured by neglect of cleanliness. They present the appearance of well-defined circular or ovoid areas in which the skin is thickened and raised above the surface; they are covered with a white sodden epidermis, and furnish a scanty but very infective discharge. Under the influence of irritation and want of rest, as at the anus or at the angle of the mouth, they are apt to become fissured and superficially ulcerated, and the discharge then becomes more abundant, and may crust on the surface, forming yellow scabs. At the angle of the mouth the condylomatous patches may spread to the cheek, and when they ulcerate may leave numerous fissure-like scars radiating from the mouth—an appearance best seen in inherited syphilis (Fig. 38).

*The Appendages of the Skin.*—The *hair* loses its gloss, becomes dry and brittle, and readily falls out, either as an exaggeration of the normal shedding of the hair or in scattered areas over the scalp. When the scalp has been the seat of a severe pustular eruption, the hair which is lost may not be replaced. *The nails* occasionally present a pustular eruption and superficial ulceration along the fold, to which the name *syphilitic onychia* has been applied; more commonly the nails become brittle and ragged, and they may even be shed.

*The Mucous Membranes*, and especially those of *the mouth* and *throat*, suffer from lesions similar to those met with on the skin. From the discomfort which they produce they are more likely to attract the attention of the patient, especially in men, so that in the diagnosis of antecedent syphilis the history of a sore mouth or throat may be of considerable assistance. On a mucous surface the papular eruption assumes the form of *mucous*

*patches*, which are areas with a congested base covered with a thin white film of sodden epithelium like wet tissue-paper. They are best seen on the inner aspect of the cheeks, the soft palate, uvula, pillars of the fauces and tonsils. When a mucous patch is in contact with a rough tooth it may give way on the surface and suppurate. In addition to mucous patches, there may be a number of small, *superficial*, *kidney-shaped ulcers*, especially along the margins of the tongue and on the tonsils. In the absence of mucous patches and ulcers, the sore throat may be characterised by a bluish tinge of the inflamed mucous membrane and a thin film of shed epithelium on the surface. Sometimes there is an elongated sinuous film which has been likened to the track of a snail. In the *larynx* the presence of congestion, œdema, and mucous patches may be the cause of persistent hoarseness. The *tongue* often presents a combination of lesions including ulcers, patches where the papillæ are absent, fissures, and raised white papules resembling warts, especially towards the centre of the dorsum. These lesions are specially apt to occur in those who smoke, drink, or eat hot condiments to excess, and in those with irregular, sharp-cornered teeth. At a later period, and in those who are broken down in health from intemperance or other cause, a serious form of sore throat may be met with in the form of rapidly spreading, penetrating ulcers in the soft palate and pillars of the fauces, and may lead to extensive destruction of tissue. In exceptional cases an ulceration commencing in the fauces spreads forwards along the palate and destroys the entire roof of the mouth.

In the *bones*, lesions occur which assume the clinical features of an evanescent periostitis, the patient complaining of nocturnal pains over the frontal bone, sternum, tibiæ and ulnæ, and localised tenderness on tapping over these bones.

In the *joints*, a serous synovitis or hydrops may occur, chiefly in the knee, on one or on both sides.

*The Affections of the Eyes*, although fortunately rare, are of great importance because of the serious results which may follow if they are not recognised and treated. *Iritis* is the commonest of these, and may occur in one or in both eyes, one after the other, from three to eight months after infection. The patient complains of impairment of sight and of frontal or supraorbital pain. The eye waters and is hypersensitive, the iris is discoloured and reacts sluggishly to light, and there is a zone of ciliary congestion around the cornea. The appearance of minute white nodules or flakes of lymph at the margin of the pupil is especially characteristic of syphilitic iritis. When

adhesions have formed between the iris and the structures in relation to it, the pupil dilates irregularly under atropin. Although complete recovery is to be expected under early and energetic treatment, if neglected, *iritis* may result in occlusion of the pupil and permanent impairment or loss of sight.

The other lesions of the eye are much rarer, and can only be discovered on ophthalmoscopic examination. *Choroiditis* occurs in patches, and leaves areas of a white or grey colour surrounded by black pigment. Unless these patches occur in the vicinity of the optic disc they give rise to no symptoms. *Neuro-retinitis*, on the other hand, attracts attention because it is attended with failure of sight in one or in both eyes; the optic disc and adjacent retina present the usual appearances of inflammation, becoming blurred and hazy.

In the *Brain*, in the later periods of secondary and in tertiary syphilis, changes occur of the nature of *endarteritis*, attended with narrowing of the lumen of the arteries, and it may be complete obliteration from superadded thrombosis. By interfering with the nutrition of those parts of the brain to which the affected arteries are distributed, these lesions give rise to clinical features of which severe headache and paralysis are the most prominent. The paralysis may involve one side of the body (hemiplegia), and be attended with convulsions and coma, or may be confined to one limb or to the area of distribution of certain of the cranial nerves. Anti-syphilitic remedies have but little curative influence in these lesions, and the paralysis is often permanent.

Affections of the *Spinal Cord* are extremely rare, but paraplegia from myelitis has been observed.

In concluding the description of the manifestations of secondary syphilis, attention must be directed to the remarkable variations observed in different patients, not only when the disease is allowed to run its course without treatment, but also when anti-syphilitic remedies have been employed. Sometimes the virulent character of the disease can only be accounted for by the idiosyncrasy of the patient. Individuals over forty years of age have greater difficulty in getting rid of the infection than younger adults. Malarial and other fevers, and the conditions attending life in tropical countries, in virtue of the debility which they cause, tend to aggravate and prolong the disease, which then assumes the characters of what has been called *malignant syphilis*. All chronic ailments have a similar influence, and alcoholic intemperance is universally regarded as a serious aggravating factor. It is a popular belief that syphilis

acquired in certain countries is of a specially virulent type, but if the factors to which reference has just been made are eliminated, there remains no evidence to support such a belief. It would appear to be rather a question of the resistance of the individual than of the virulence of the infecting agent. These considerations have an important bearing on the treatment of the disease.

*Diagnosis of Secondary Syphilis.*—It should be made a routine practice when a patient presents manifestations which are possibly of a syphilitic nature, to make a systematic examination of the parts of the body which are most often affected in this disease—the scalp, mouth, throat, posterior cervical glands, and the trunk, the patient being stripped, and examined in a good light. Among the *diagnostic features of the skin affections* the following may be mentioned:—They are frequently, and sometimes to a marked degree, symmetrical; several types of eruption—papules and pustules, for example—may be present at the same time; there is little itching; they are at first a dull-red colour, but later present a brown pigmentation which has been likened to the colour of raw ham; they exhibit a predilection for those parts of the forehead and neck which are close to the roots of the hair; they tend to pass off spontaneously; and they disappear rapidly under the influence of mercury.

**Treatment of Secondary Syphilis.**—There are two main objects in the treatment of syphilis: to maintain the general health at the highest possible standard, and to place the patient thoroughly under the influence of mercury. It is now universally admitted that these objects are not incompatible with one another.

*The General Health.*—The patient must lead a regular life and cultivate the fresh-air habit, which is as beneficial in syphilis as in tuberculosis. Anæmia, malaria, and other sources of debility must receive appropriate treatment. The diet should be simple and easily digested, and should include a full supply of milk. Alcohol is prohibited unless it is required as a food, in which case beer, claret, or stout may be allowed at meals. The excretory organs are encouraged to act by the liberal drinking of hot water between meals, say five or six tumblerfuls in the twenty-four hours. The functions of the skin are further aided by frequent hot baths, and by the wearing of warm underclothing. While the patient should avoid exposure to cold, or taxing his energies by undue exertion, he should be advised to take exercise in the open air. On account of the liability to

lesions of the mouth and throat he should use tobacco in moderation, his teeth should be thoroughly overhauled by the dentist, and he should brush them after every meal, using an antiseptic tooth powder or wash. The mouth and throat should be rinsed out night and morning with a solution of chlorate of potash and alum.

*The Administration of Mercury.*—As soon as the diagnosis is established, the patient should be brought under the influence of mercury, as this drug is the only specific remedy for syphilis. The amount of mercury to be given in any case must be proportioned to the idiosyncrasies of the patient. The dose is at first gradually increased until there appears a trace of soreness at the edge of the gums; it is then diminished so as just to fall short of producing this effect. Having thus discovered the proper dose for the individual, it should be continued for two years unless any contra-indication develops. If the body weight falls, or if the gums become sore and the breath foul, the mercury should be stopped for a time. If there is actual salivation, the drinking of hot water and the taking of hot baths should be insisted upon, and half-dram doses of the alkaline sulphates prescribed. The toilet of the teeth and mouth, which is so essential during a course of mercury, has already been referred to.

*Methods of Administering Mercury.*—(1) *By the Mouth.*—This has long been the most popular method in this country, the preparation usually employed being grey powder, in pills or tablets, each of which contains one grain of the powder. Three of these are given daily in the first instance, and the daily dose is increased to five or even seven grains till the standard for the individual patient is arrived at. As the grey powder alone sometimes causes irritation of the bowels, it should be combined with iron, as in the following formula:—Hydrarg. c. cret. gr. 1; ferri sulph. exsiccat. gr. 1 or 2.

When the grey powder fails to relieve or does not agree with the patient, some other preparation may be substituted, such as the green iodide of mercury, in doses of quarter or half a grain, gradually raised to one grain three times a day; or the liquor of the perchloride of mercury in dram doses.

(2) *By Inunction.*—Inunction consists in rubbing into the skin an ointment composed of equal parts of 20 per cent. oleate of mercury and lanolin. Every night, or night and morning, after a hot bath, a portion of the ointment about the size of a hazel nut is rubbed for fifteen minutes into the skin where it is soft and comparatively free from hairs. Different parts of the

body should be selected in rotation, and scrupulous cleanliness observed so as to avoid septic irritation of the skin. As the patient dresses with traces of the ointment on the skin, the underclothing becomes impregnated with mercury, and as it cannot be washed, it is thrown away when soiled. Inunction is undoubtedly troublesome, but is by far the most efficient method of bringing the patient rapidly under the influence of mercury, and it is therefore specially valuable in syphilis where time has already been lost and the patient first seeks advice for an *iritis* or other late lesion. It is also of value in cases of cerebral syphilis, in syphilis appearing after marriage, and in cases where the symptoms persist in spite of the administration of mercury by the mouth.

(3) *By Intramuscular Injection.*—This consists in introducing the drug by means of a hypodermic syringe into the substance of the gluteal muscles. The skin of the patient, the preparation employed, and the instrument must be sterilised. The syringe is made of glass and has a solid glass piston; the needle of platinum should be 5 cm. long. The preparation usually employed consists of: metallic mercury one dram, lanolin and olive oil each two drams, and it must be warmed to allow of its passage through the needle. Five minims—containing one grain of metallic mercury—represent a dose, and this is injected into the muscles above and behind the great trochanter once a week. Four courses of ten injections are given the first year, three courses of the same number during the second and third years, and two courses during the fourth year (Lambkin). This method has been found specially useful by army surgeons who cannot rely on the men taking pills, and as the injection is only made at intervals the patient need not be admitted to hospital; unless, however, the dose is regulated with great accuracy, mercurial poisoning may result, with, it may be, serious consequences. We have used the method in the Lock Wards of the Royal Infirmary, and have been satisfied with the results obtained; it is, however, inferior to inunction in the rapidity with which the patient is mercurialised, and in private practice is not so convenient as administration by the mouth.

(4) *The Calomel Vapour Bath* (fumigation) may be employed in cases with persistent skin lesions.

(5) *The Merco-lint Bib or Apron* contains finely divided metallic mercury in its meshes, and when worn next the skin the mercury evaporates and is believed to be inhaled by the patient as well as absorbed by the skin. It may be used as an adjuvant to mercury pills when the patient is unable,

through gastric disturbance, to take the full number required. The bib should be changed once a fortnight, as the mercury is lost by evaporation.

*Iodides in Secondary Syphilis.*—While generally recognised as being of little or no use at the beginning of the secondary stage, iodides are of great value in the treatment of the later manifestations, especially those which approach in character the lesions of the tertiary period and do not yield to mercury alone, such as the deeper lesions in the skin and throat, and in the nervous system. The iodide of potassium or sodium is given in five to fifteen grain doses thrice daily, either in solution along with the bichloride of mercury, or separately in the form of tablets. When iodides are given to a patient who has been taking a course of mercury, their effects must be carefully watched, as the iodides liberate mercury which has accumulated in an insoluble form in the tissues, and salivation may result. After the termination of a full course of mercury, and when all manifestations have disappeared, French authorities recommend a two to three months' course of the iodides alone.

In cases with marked general debility and with cachexia, where mercury and iodides have failed to give relief or appear even to aggravate the disease (and this is most often the case in patients who have resided in tropical countries), a trial should be given to sarsaparilla taken in large quantities of hot water. One of the best-known preparations is *Zittmann's decoction*,[1] which contains sarsaparilla, fennel, anise, liquorice, and senna. A pill containing two grains of calomel is given at intervals of four days. We can bear out the statement that it often acts like a charm when all other treatment has failed.

*Treatment of the Local Manifestations.*—*The skin lesions* are treated on the same lines as similar eruptions of other origin. As local applications, preparations of mercury are usually selected, notably the ointments of the red oxide of mercury, ammoniated mercury, or oleate of mercury (5 per cent.), or the mercurial plaster introduced by Unna. In the treatment of condylomata the greatest attention must be paid to cleanliness and dryness. After washing and drying the affected patches, they are dusted with a powder consisting of equal parts of calomel and carbonate of zinc; and apposed skin surfaces, such as the nates or labia, are separated by sublimate wool. In the ulcers of later secondary syphilis, crusts are got

[1] The formula is given in the First Report by the Advisory Board for Army Medical Services on the Treatment of Venereal Disease and Scabies in the Army, 1904, p. 32.

rid of in the first instance by means of a boracic poultice, after which a piece of lint or gauze cut to the size of the ulcer and soaked in black wash is applied and covered with oil-silk. If the ulcer tends to spread in area or in depth, it should be scraped with a sharp spoon, and painted over with pure carbolic acid or acid nitrate of mercury.

*In lesions of the mouth and throat*, the teeth should be attended to with special care; the best local application is a solution of chromic acid—ten grains to the ounce—painted on with a brush once daily or every alternate day. If this fails, the lesions may be dusted the last thing at night with calomel. For deep ulcers of the throat the patient should gargle frequently with chlorine water or with perchloride of mercury (1 in 2000); if the ulcer continues to spread it should be painted with acid nitrate of mercury.

In the treatment of *iritis* the eyes are shaded from the light and completely rested, and the pupil is well dilated by atropin in order to prevent adhesions. If there is much pain a blister may be applied to the temple.

*The Relations of Syphilis to Marriage.*—Even under the most favourable conditions, no patient should be allowed to marry until three years have elapsed after the last manifestation has disappeared. While marriage may be entered upon under these conditions without risk of the husband infecting the wife, the possibility of his conveying the disease to the offspring cannot be absolutely excluded. It has been recommended as a precautionary measure, to give a further mercurial course of two or three months' duration before marriage. In view of the fact that women who have suffered from syphilis retain the liability to transmit the disease to their offspring much longer than men, the responsibility of permitting them to marry should rarely, if ever, be undertaken.

**Intermediate Stage.**—After the dying away of the secondary manifestations and before the appearance of tertiary lesions, the patient may present certain symptoms which Hutchinson has called *reminders*. These usually consist of relapses of certain of the affections of the skin, mouth, or throat, already described. In the skin, they may assume the form of peeling patches in the palms, or may appear as spreading and confluent circles of a scaly papular eruption, which if neglected may lead to the formation of fissures and superficial ulcers. They are easily cured but readily relapse. Less frequently there is a relapse of the eye affections, or of paralytic symptoms from disease of the cerebral arteries.

Treatment is conducted on the same lines as in late secondary syphilis, mercury and iodides being given in combination. Sometimes the preparation known as Donovan's solution, containing the double iodide of mercury and arsenic, is to be preferred. The general health usually requires to be built up by tonics and change of air, and a sea-voyage may be found of great value in increasing the resisting powers of the patient.

**Tertiary Syphilis.** — Although a two years' course of mercury nearly always prevents the manifestations which fall to be described under this head, it is impossible to give a guarantee to this effect in any individual case. While the manifestations of primary and secondary syphilis are common, those of the tertiary period are by comparison rare, and are observed chiefly in those who have either neglected treatment or who have had their powers of resistance lowered by privation, by alcoholic indulgence, or by tropical disease.

The *general characters of tertiary manifestations* may be stated as follows. They attack by preference the tissues derived from the mesoblastic layer of the embryo—the cellular tissue, bones, muscles, and viscera. They are often localised to one particular tissue or organ, such, for example, as the subcutaneous cellular tissue, the bones, or the liver, and they are rarely symmetrical. They are usually aggressive and persistent, with little tendency to natural cure, and they may be dangerous to life, because of the destructive changes produced in such organs as the brain or the larynx. They are remarkably amenable to treatment by iodides, if these are given before that stage is reached which is attended with destruction of tissue. Early tertiary lesions may be infective and the disease may be transmitted by the discharges from them; but the later the lesions the less is the risk of their containing an infective virus. The most prominent feature of tertiary syphilis consists in the formation of granulation tissue, and this takes place on a scale considerably larger than that observed in lesions of the secondary period. The granulation tissue frequently forms a definite swelling or tumour-like mass (syphiloma), which, from its peculiar elastic consistence, is known as a *gumma*. The gumma does harm by displacing and replacing the normal tissue elements of the part affected, and by involving these in the degenerative changes, of the nature of caseation and necrosis, which it is liable to undergo, and which result in the well-known destructive lesions of the skin, mucous membranes, and internal organs. This is true not only of the circumscribed mass or gumma, but of the condition in which the

granulation tissue is diffused throughout the connective-tissue framework of such organs as the tongue or liver, and which is known as *gummatous infiltration* or syphilitic cirrhosis.

The life-history of an untreated gumma varies with its environment. When protected from injury and irritation in the substance of an internal organ such as the liver, it may become encapsulated by fibrous tissue and persist in this condition for an indefinite period, or it may be absorbed and leave in its place a fibrous cicatrix. In the interior of a long bone it may replace the rigid framework of the shaft to such an extent as to lead to pathological fracture. If it is near the surface of the body—as for example, in the subcutaneous or submucous cellular tissue, or in the periosteum of a superficial bone, such as the palate, the skull, or the tibia—the tissue of which it is composed is very apt to undergo necrosis in which the overlying skin or mucous membrane frequently participates, the result being an ulcer — the tertiary syphilitic ulcer (Figs. 19, 37).



FIG. 37.—Tertiary Syphilitic Ulceration in region of Knee and on both Thumbs of woman æt. 37.

*Tertiary Lesions of the Skin and Subcutaneous Cellular Tissue.*—The clinical features of a *subcutaneous gumma* are those of an indolent, painless, elastic swelling, varying in size from that of a pea to that of an almond or walnut. After a variable period it usually softens in the centre, the skin over it becomes livid and dusky, and finally separates as a slough, exposing the tissue of the gumma, which sometimes appears as a mucoid, yellowish, honey-like substance; more frequently as a sodden, caseated tissue resembling wash-leather. The caseated tissue of a gumma differs from the corresponding tissue of a tuberculous lesion in being tough and firm, of a buff colour like

wash-leather, or whitish, like boiled fish. Unlike the contents of a tuberculous abscess, the degenerated tissue of a gumma separates slowly and gradually, and may be visible for weeks in the floor of the ulcer.

*The tertiary ulcer* may be situated anywhere, but is most frequently met with on the legs, especially in the region of the knee (Fig. 37) and over the calf. There may be one or more ulcers, and there may be scars of antecedent ulcers. The edges are sharply cut, as if punched out; the margins are rounded in outline, firm, and congested; the base is occupied by gummatous tissue, or, if this has already separated and sloughed out, by unhealthy granulations and a thick purulent discharge. When the ulcer has healed it leaves a scar which is depressed, and if over a bone, is adherent to it. The features of the tertiary ulcer, however, are not always so characteristic as the above description would imply. It is to be diagnosed from the "leg ulcer" which occurs almost exclusively on the lower third of the leg; from Bazin's disease (p. 79); from the ulcers which result from certain forms of malignant disease, such as rodent cancer, and finally from those met with in chronic glanders.

*Gummatous Infiltration of the Skin* ("syphilitic lupus").—This is a lesion, met with chiefly in the face and in the region of the external genitals, in which the skin becomes infiltrated with granulation tissue so that it is thickened, raised above the surface, and of a brownish-red colour. It appears as isolated nodules, which may fuse together; the epidermis becomes scaly and is shed, giving rise to superficial ulcers which are usually covered by crusted discharge. The disease tends to spread, creeping over the skin with a serpiginous, crescentic or horseshoe margin, while the central portion may heal and leave a scar. When untreated the lesion is a very persistent and destructive one. From the fact of its healing in the centre while it spreads at the margin, it may simulate tuberculous disease of the skin. The syphilitic affection can usually be differentiated by observing that the infiltration of the skin is on a larger scale; the progress of the disease is much more rapid, involving in the course of months an area which in the case of tuberculosis would require as many years; the scars formed are sounder and are less liable to break down again; and, finally, the disease rapidly yields to anti-syphilitic treatment.

*Tertiary lesions of mucous membranes and of the submucous cellular tissue* are met with chiefly in the tongue, nose, throat, larynx, and rectum. They originate as gummata or as gummatous infiltrations which are liable to break down and lead to

the formation of ulcers which may prove locally destructive, and, in such situations as the larynx, even dangerous to life. In the tongue the tertiary ulcer may prove the starting-point of cancer; and in the larynx or rectum the healing of the ulcer may be associated with serious cicatricial stenosis or stricture of the passage affected.

Tertiary lesions of the *bones and joints*, of the *muscles*, and of the *internal organs* will be described under these heads. The part played by syphilis in the production of atheroma and of aneurysm will be referred to along with diseases of blood-vessels.

*Diagnosis.*—From the enormous diversity in the nature and seat of the lesions met with in tertiary syphilis, it is impossible to lay down any general rules for diagnosis, but the student may be cautioned, on the one hand, against relying upon the absence of a history of antecedent syphilis, and, on the other, of indulging in the habit of diagnosing lesions as syphilitic simply because their origin is obscure.

*Treatment.*—The most valuable drugs for the treatment of the manifestations of the tertiary period are the iodides of sodium and potassium. While iodides are most effective in promoting the absorption of recent gummata and gummatous infiltrations, they do not remedy the destructive changes brought about by gummata. On account of their depressing effects, they are frequently prescribed along with carbonate of ammonium. The dose is usually a matter of experiment in each individual case; five grains three times a day may suffice, or it may be necessary to increase each dose to twenty or twenty-five grains. The symptoms of iodism which may follow from the smaller doses usually disappear on giving a larger amount of the drug. It should be taken after meals, with abundant water or other fluid, especially if given in tablet form. It is advisable to continue the iodides for from one to three months after the lesions for which they are given have cleared up. If the potassium salt is not tolerated, it may be replaced by the ammonium or sodium iodide. A combination of the perchloride of mercury with iodides usually yields more lasting results than the iodides alone. The general health should receive the same careful attention as during the secondary period; much assistance is often obtained from tonics such as arsenic, iron, quinine, and strychnine, from cod-liver oil, and from change of air either by land or sea.

*The Local Treatment.*—The absorption of a subcutaneous gumma is hastened by the application of a fly-blister. The incision of a gumma is scarcely ever called for. When a gumma has broken on the surface and left an ulcer, this is treated on

general principles, with a preference, however, for applications containing mercury or iodine, or both. If a wet dressing is required to cleanse the ulcer, black wash may be used; if a powder to promote dryness, one containing iodoform; if an ointment is indicated, the choice lies between the red oxide of mercury or the dilute nitrate of mercury ointment, and one consisting of equal parts of lanolin and vaselin with two per cent. of iodine. Where there is any spreading tendency in ulcers of the skin or mucous membrane, the surface may be cauterised with the acid nitrate of mercury. Deep ulcers, lesions of the bones, larynx, and other parts which prove obstinate, may be treated like the corresponding lesions in tuberculosis—that is, by operative measures directed towards the removal of the diseased tissues.

**Second attacks of syphilis**, although very rare, do occur, especially in those who have been treated and cured by mercury. So long as the virus of syphilis remains active in the system, it protects the patient against a second attack. As a rule, therefore, there is an interval of several years before a patient who has had syphilis can contract the disease a second time, and when he does so, it is less severe and more amenable to treatment than the first attack.

As connected with this subject, we may refer to the **relapsing false indurated chancre**, described by Hutchinson and by Fournier, as it may be the source of considerable difficulty in diagnosis. A patient who has had an infecting chancre one or more years before, presents a slightly raised induration on the penis at or close to the site of his original chancre. Often the relapsed induration is so like that of a primary chancre that it is impossible to distinguish it except by the history. If he has lately been exposed to venereal infection it is liable to be regarded as the primary lesion of a second attack of syphilis, but the further progress of the case shows neither bullet-buboes nor secondary manifestations. These facts, together with the disappearance of the induration under iodides, make it very likely that the lesion is really gummatous in character.

### Inherited Syphilis.

One of the most striking features of syphilis is that it may be transmitted from parents who have suffered from the disease to their offspring, the children exhibiting the manifestations which characterise the acquired affection.

The more recent the syphilis in either parent the greater

is the risk of the disease being communicated to the offspring; so that if either parent suffers from secondary syphilis the infection is almost inevitably transmitted. The capacity of transmitting the disease, however, may be extended after the disappearance of all secondary manifestations. The longer the interval between the time that the parent contracted syphilis and conception, the less likely is the disease to be transmitted.

While it is certain that either parent may be responsible for transmitting the disease to the next generation, the exact method of transmission is not known. It is most probable that in the case of a syphilitic mother the infection is conveyed to the fœtus by the placental circulation. In the case of a syphilitic father, it is commonly believed that the infection is conveyed to the ovum through the seminal fluid at the moment of conception. If a series of children, one after the other, suffer from inherited syphilis, it is almost invariably the case that the mother has herself suffered from syphilis.

The syphilitic virus exercises a most injurious influence on the fœtus. In many cases the fœtus dies during the early months of intra-uterine life so that miscarriage results, and this may take place in repeated pregnancies, the date at which the miscarriage occurs becoming later and later as the virus in the mother becomes attenuated, until eventually a child is carried to full term. The child is still-born, or if born alive may suffer from syphilitic manifestations. In recently infected mothers a viable fœtus is rarely produced. It has usually been taught that in a family of syphilitic children the elder ones suffered more severely than the younger because they came nearer to the parental infection, but it would appear that there is no such variation in severity. It is impossible to explain such vagaries of syphilitic inheritance as the infection of one twin and the escape of the other.

*Clinical Features.*—We are not here concerned with the severe forms of the disease which soon prove fatal, but with the milder forms in which the infant is apparently healthy when born, but after from two to six weeks begins to show evidence of the syphilitic taint.

The usual phenomena are that the child ceases to thrive, becomes thin and sallow, suffers from eruptions on the skin and mucous membranes. There is frequently a characteristic condition known as *snuffles*, in which the nasal passages are obstructed by an accumulation of thin muco-purulent discharge which causes the breathing to be noisy. A similar condition may be met with in young infants from a simple catarrh,

but when it persists and is attended with mucous patches in the nostrils, it is very suggestive of syphilis. It usually begins within a month after birth and before the eruptions on the skin appear. When long continued it is liable to interfere with the development of the nasal bones, so that when the child grows up the bridge of the nose is deficient, the condition being known as the "saddle-nose" deformity (Fig. 38).

*Affections of the Skin.*—Although all types of skin affection are met with in the inherited disease, the most important is a *papular* eruption, the papules being of large size, with a smooth shining top and of a reddish-brown colour. It affects chiefly the buttocks and posterior aspect of the thighs, the external genitals, and other parts which are constantly moist. It is necessary to distinguish this specific eruption from a form of eczema which frequently occurs in these situations in non-syphilitic children, the points which characterise the syphilitic condition being the infiltration of the skin and the coppery colour of the eruption. At the angles of the mouth and at the anus the papules acquire the characters of *condylomata* (Fig. 39). At the angles of the mouth they often ulcerate and leave fine radiating scars (Fig. 38).



FIG. 38.—Facies of Inherited Syphilis in a girl æt. 20.

*Affections of the Mucous Membranes.*—The inflammation of the nasal mucous membrane which causes snuffles has already been referred to. There may be mucous patches in the mouth, or a general inflammation or stomatitis which is of special importance because it frequently results in interference with the development of the permanent teeth. The mucous membrane of the larynx may be the seat of mucous patches or of catarrh, and as a result the child's cry may be hoarse.

*Affections of the bones.*—Swellings at the ends of the long bones, due to inflammation at the epiphysial junctions, are most often observed at the upper end of the humerus and in the bones in the region of the elbow. Partial displacement and mobility at the ossifying junction may be observed. The infant cries when the part is touched; and as it does not move the limb voluntarily, the condition is spoken of as *the pseudo-paralysis of syphilis.* Recovery takes place under anti-syphilitic treatment and immobilisation of the limb.

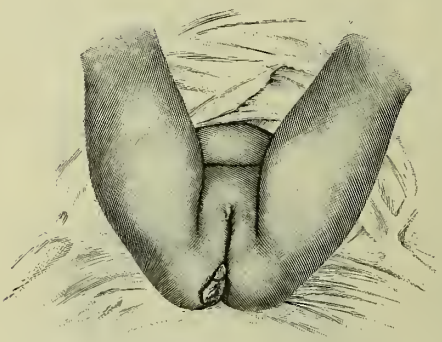


FIG. 39.—Condylomata of Anus in an infant the subject of Inherited Syphilis.
(From a photograph lent by Mr. Stiles.)

Diffuse thickening of the shafts of the long bones due to a deposit of new bone by the periosteum is sometimes met with.

In the skull, especially of infants who suffer also from rickets, two characteristic conditions may be met with, respectively known as Parrot's nodes or bosses, and craniotabes. *The bosses* (Fig. 40) result from the heaping up of new spongy bone beneath the pericranium, and they may be grouped symmetrically around the anterior fontanelle, or may extend along either side of the sagittal suture, which appears as a deep groove—the "natiform skull." The bosses disappear in time, but the skull may remain permanently altered in shape, the frontal and parietal eminences often appearing unduly prominent. The term *cranio-*

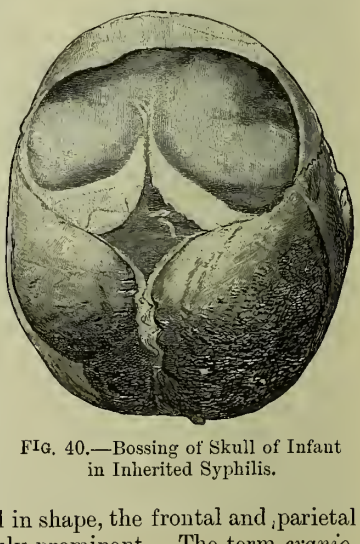


FIG. 40.—Bossing of Skull of Infant in Inherited Syphilis.

*tabes* is applied when the bone becomes thin and soft, reverting to its original membranous condition, so that the areas affected dimple under the finger like parchment or thin cardboard; its localisation in the posterior parts of the skull indicates that the disappearance of the osseous tissue is influenced by the pressure of the head on the pillow. Craniotabes is entirely recovered from as the child improves in health.

Between the ages of three and six months, certain other phenomena may be observed, such as *effusion into the joints*, especially the knees; *iritis*, in one or in both eyes—a condition which, however, is liable to be overlooked; and enlargement of the spleen and of the liver.

In the majority of cases the child recovers from these early manifestations, especially when treated with mercury, and may enjoy an indefinite period of good health. On the other hand, when it attains the age of two to four years it may begin to manifest lesions which correspond to those of the tertiary period of acquired syphilis. In other cases the infant fails in health from day to day, its cry is hoarse and feeble, its capacity for sucking diminishes, it becomes emaciated and dies of exhaustion.

**Later Lesions.**—In the skin and subcutaneous tissue the later manifestations may take the form of localised gummata which tend to break down and form ulcers, on the leg for example, or of a spreading gummatous infiltration which is also liable to ulcerate, leaving disfiguring scars, especially on the face. The palate and fauces may be destroyed by ulceration. In the nose, especially when the ulcerative process is associated with a putrid discharge—ozæna—the destruction of tissue may be considerable and result in the most unsightly deformities. The entire palatal portions of the upper jaws, the vomer, turbinate and other bones bounding the nasal and oral cavities, may ultimately disappear, so that on looking into the mouth the base of the skull is readily seen. Gummatous disease is frequently observed also in the flat bones of the skull, in the bones of the hand, as syphilitic dactylitis, and in the bones of the forearm and leg. When the tibia is affected the disease is frequently bilateral, and may assume the form of gummatous ulcers and sinuses. In later years the tibia may present alterations in shape resulting from antecedent gummatous disease—for example, nodular thickenings of the shaft, flattening of the crest, or a more uniform increase in thickness and length of the entire shaft of the bone, which, when it is curved in addition, is described as the "sabre-blade" deformity. Among the lesions of the viscera mention should be made of gumma of

the testis, which causes the organ to become enlarged, uneven, and indurated. This has even been observed in infants a few months old.

Occasionally a syphilitic child suffers from a succession of these gummatous lesions which causes persistent ill-health, and, it may be, waxy disease of the internal organs; on the other hand, it may recover and present no further manifestations of the inherited taint.

*Eye Symptoms.*—At or near puberty there is frequently observed an affection of the eyes, known as *chronic interstitial keratitis*, the relationship of which to inherited syphilis was first established by Hutchinson. It occurs between the ages of five and eighteen years, and usually affects one eye before the other. It commences as a diffuse haziness or steaminess near the centre of the cornea, and as it spreads, the entire cornea assumes the appearance of ground glass. The chief complaint is of dimness of sight which may almost amount to blindness, but there is little pain or photophobia; a certain amount of conjunctival and ciliary congestion is usually present, and there may be *iritis* in addition. The cornea, or parts of it, may become of a deep pink or salmon colour from the formation in it of new blood-vessels. The affection may last for from eighteen months to two years. Complete recovery usually takes place, but slight opacities, especially in the site of former salmon patches, may persist, and the disease occasionally relapses. *Choroiditis* and *retinitis* may also occur, as in acquired syphilis.



FIG. 41.—Showing appearance of Permanent Teeth in case of Inherited Syphilis—"Hutchinson Teeth."

Among the rarer and more serious lesions of the inherited disease may be mentioned gummatous disease in the *larynx and trachea*, attended with ulceration and resulting in stenosis; and lesions of the *nervous system* which may result in convulsions, paralysis, or dementia.

In a limited number of cases, about the period of puberty there may develop *deafness*, which is usually bilateral and may become absolute.

*Changes in the Permanent Teeth.*—These affect specially the upper central incisors, which are dwarfed and stand somewhat apart in the gum with their free edges converging towards one another. They are tapering or peg-shaped, and present at their cutting margin a deep semilunar notch (Fig. 41). These

appearances are commonly associated with the name of Hutchinson, who first described them. Affecting as they do the permanent teeth, they are not available for diagnosis until the child is about eight years of age.

**Diagnosis of Inherited Syphilis.**—When there is a typical eruption on the buttocks and snuffles there is no difficulty in recognising the disease. When, however, the rash is scanty or is obscured by co-existing eczema, most reliance should be placed on the distribution of the eruption, on the brown stains which are left after it has passed off, on the presence of condylomata, and of fissuring and scarring at the angles of the mouth. The history of the mother relative to repeated miscarriages and still-born children may afford confirmatory evidence. In doubtful cases, the diagnosis may be aided by noting the therapeutic effects of grey powder, which, in syphilitic infants, usually effects a marked and rapid improvement in the symptoms and in the general health.

**Latent Hereditary Syphilis** is that form in which tertiary manifestations appear for the first time in adolescence.

While a considerable number of syphilitic children grow up without showing any trace of their syphilitic inheritance, the majority retain throughout life one or more of the following characteristics, which may therefore be described as *permanent signs of the inherited disease*:—Dwarfing of stature from interference with growth at the epiphysial junctions; the forehead low and vertical, and the parietal and frontal eminences unduly prominent; the bridge of the nose sunken and rounded; radiating scars at the angles of the mouth (Fig. 38); perforation or destruction of the hard palate; Hutchinson's teeth; opacities of the cornea from antecedent keratitis; alterations in the fundus oculi from choroiditis; deafness; depressed scars or nodes on the bones from previous gummata; "sabre-blade" or other deformity of the tibiæ.

**The Contagiousness of Inherited Syphilis.**—In 1837 Colles, of Dublin, stated his belief that while a syphilitic infant may convey the disease to a healthy wet nurse, it is incapable of infecting its own mother if nursed by her, even although she may never have shown any symptoms of the disease. This doctrine, which is known as *Colles' law*, is generally accepted in spite of the alleged occurrence of occasional exceptions. The older the child the less risk there is of its communicating the disease to others, until eventually the tendency dies out altogether, as it does in the tertiary period of acquired syphilis. It should be added, however, that the contagiousness

of inherited syphilis is denied by some observers, who affirm that when syphilitic infants prove contagious the disease has been really acquired at or soon after birth and is therefore not inherited.

There is general agreement that the subjects of inherited syphilis cannot transmit the disease by inheritance to their offspring, and that although they very rarely acquire the disease *de novo*, it is quite possible for them to do so when exposed to infection in the ordinary way.

*Prognosis of Inherited Syphilis.*—Although inherited syphilis is responsible for a large, but apparently diminishing, mortality in infancy, the subjects of this disease may grow up to be as strong and healthy as their neighbours. Hutchinson insists on the fact that there is very little bad health in the general community that can be attributed to inherited syphilis.

*Treatment.*—An infant the subject of inherited syphilis should, if possible, be nursed by its mother, and failing this it should be fed by hand. On the first appearance of syphilitic manifestations it should be brought under the influence of mercury. This is best given as grey powder in half or one grain doses thrice daily; it may be mixed with powdered sugar, or, if digestive derangements arise, may be combined with bismuth or soda. As a rule the grey powder is remarkably well borne by infants, and if they continue to thrive under it, it should be given for from three to six months after all symptoms have disappeared. If the internal administration of mercury does not suit the infant, it may be replaced by inunction. The dilute oleate of mercury is rubbed into the sides of the chest and abdomen, or is applied on the flannel binder twice or thrice weekly. The local lesions are treated on the same lines as in the acquired disease. The general health should be improved in every possible direction; considerable benefit may be derived from the use of cod-liver oil, and from preparations containing iron and calcium. The gummatous lesions are treated on the same lines as in the acquired disease, but it should be pointed out that in inherited syphilis they are frequently found to be less amenable to the influence of iodides, and dependence must largely be placed on measures calculated to improve the general health. Surgical interference may be required in the destructive gummatous lesions of the nose, throat, larynx and bones, either with the object of arresting the spread of the disease, or of removing or alleviating the resulting deformities. In children suffering from keratitis, the eyes should be protected from the light by smoked or coloured glasses, and the pupils

should be dilated with atropin from time to time, especially in cases complicated with *iritis*.

**Acquired Syphilis in Infants and Young Children.**—When syphilis is met with in infants and young children, it is apt to be taken for granted that the disease has been inherited. It is possible, however, for them to acquire the disease—as, for example, while passing through the maternal passages during birth, through being nursed or kissed by infected women, or through the rite of circumcision. The risk of infection which formerly existed by the arm-to-arm method of vaccination has been abolished by the general use of calf lymph.

The clinical features of the acquired disease in infants and young children are very similar to those observed in the adult, with a tendency, however, to be more severe, probably because the disease is often late in being recognised and treated.

# CHAPTER XI.

## TUMOURS.[1]

Definition—Etiology—General characters of innocent and malignant tumours. CLASSIFICATION OF TUMOURS: I. Connective-tissue tumours: (1) *Innocent: Lipoma, Xanthoma, Chondroma, Osteoma, Odontoma, Fibroma, Myxoma, Endothelioma*, etc.; (2) *Malignant: Sarcoma*—II. Epithelial tumours: (1) *Innocent: Papilloma, Adenoma, Cystic Adenoma;* (2) *Malignant: Epithelioma, Glandular Cancer, Rodent Cancer, Melanotic Cancer*—III. Dermoids—IV. Teratomata. Cysts: *Retention, Exudation, Implantation, Parasitic, Lymphatic or Serous.* Ganglion.

A TUMOUR or neoplasm is a localised swelling composed of newly formed tissue which fulfils no physiological function. Tumours tend to grow quite independently of the growth of the body, and there is no natural termination to their growth. They are to be distinguished from such over-growths as are of the nature of simple hypertrophy or local giantism, and also from inflammatory swellings, which usually develop under the influence of a definite cause, which have a natural termination, and which tend to disappear when the cause ceases to act.

The *etiology of tumours* is at present very imperfectly understood. Various factors, acting either singly or in combination, may be concerned in their development. Certain tumours, for example, are the result of some congenital malformation of the particular tissue from which they take origin. This would appear to be the case in many tumours of blood-vessels (angiomata), of cartilage (chondromata), of bone (osteomata), and of secreting gland tissue (adenomata). The theory that tumours originate from fœtal residues or "rests" is associated with the name of Cohnheim. These rests are supposed to be undifferentiated embryonic cells which remain embedded amongst fully formed

[1] For the histology of tumours the reader is referred to a text-book of pathology.

tissue elements, and lie dormant until they are excited into active growth and give rise to a tumour. This mode of origin is illustrated by the development of dermoids from sequestrated portions of the epidermis.

Among the local factors concerned in the development of tumours, reference must be made to the influence of irritation and inflammation. These are probably important agents in the causation of many of the tumours met with in the skin and in mucous membranes—for example, cancer of the skin, of the lip, and of the tongue. The part played by a definite injury is doubtful. It not infrequently happens that the development of a tumour is preceded by an injury of the part in which it grows, but it does not necessarily follow that the injury and the tumour are related as cause and effect. It is possible that an injury may stimulate into active growth undifferentiated tissue elements or "rests," and so determine the growth of a tumour, or that it may alter the characters of a tumour which already exists, causing it to grow more rapidly.

The view that the development of tumours is determined by micro-organisms, which has attracted so much attention in recent years, is still under discussion and investigation.

The popular belief that there is some constitutional peculiarity concerned in the causation of tumours is largely based on the fact that certain forms of new growth—for example, cancer—are known to occur with undue frequency in certain families. Some innocent tumours—particularly multiple osteomata and lipomata—are hereditary in the same sense as congenital deformities, such as supernumerary or webbed fingers, and may appear in members of the same family through several generations.

### Innocent and Malignant Tumours.

For clinical purposes tumours are arbitrarily divided into two great classes—the innocent and the malignant. The outstanding difference between these two classes is, that while the evil effects of innocent tumours are merely local and depend for their severity on the environment of the growth, malignant tumours wherever situated, in addition to producing local effects, injure the general health of the patient and ultimately cause his death.

*Innocent*, benign, or simple tumours present a close structural resemblance to the normal tissues of the body. They grow slowly, and are usually definitely circumscribed by a fibrous capsule. They are easily enucleated from their capsule, and they do not tend to recur after removal. In their growth they

merely push aside and compress adjacent parts, and they present no tendency to ulcerate and bleed unless the overlying skin or mucous membrane is injured from without. They form no attachment to adjacent parts except as a result of accidental inflammation. Although usually solitary, some of them may be multiple from the outset—for example, fatty, fibrous, and bony tumours, warts, and fibroid tumours of the uterus. They produce no constitutional disturbance, wasting, or cachexia. They only threaten life when growing in the vicinity of vital organs, and there merely in virtue of their situation—for example, death may result from an innocent tumour in the air-passages causing suffocation, in the intestine causing obstruction of the bowels, or in the spinal canal causing pressure on the cord.

*Malignant tumours* usually show a marked departure from the normal structure and arrangement of the tissues of the body. They grow more rapidly than innocent tumours, and they tend to infiltrate their surroundings by sending out prolongations or offshoots into the surrounding tissues. They are therefore very liable to recur after an operation which is restricted to the removal of the main tumour. They are not encapsulated, although they may appear to be circumscribed by condensation of the surrounding tissues. They are rarely multiple at the outset. They show a marked tendency, however, to spread to other parts of the body. Fragments of the parent tumour may become separated and be carried off in the lymph or blood-stream and deposited in other parts of the body, where they give rise to secondary growths. Malignant tumours tend to invade and destroy the overlying skin or mucous membrane, and thus give rise to bleeding ulcers; if the tumour tissue protrudes through the gap in the skin, it is said to *fungate*. They may give rise to a condition of general ill-health or *cachexia*, the patient becoming pale, sallow, feverish, and emaciated, probably as a result of chronic poisoning from the absorption of toxic products from the tumour. They ultimately destroy life, it may be by their local effects, such as ulceration and hæmorrhage, by favouring the entrance of septic infection, by interfering with the function of organs which are essential to life, by cachexia, or by a combination of these effects.

It may be added that the situation of a malignant tumour exercises considerable influence on the rapidity, as well as on the mode, in which it causes death. Some cancers, such as that known as "rodent," show malignant features which are entirely local, while others, such as melanotic cancer, exhibit a malignancy characterised by a rapid generalisation of tumour growths

throughout the body. Tumours which are structurally alike may show variations in malignancy, not only according to their situation, but also according to the age of the patient and to other factors which are as yet unknown.

In attempting to arrive at a conclusion as to the innocence or malignancy of any tumour, too much reliance must not be placed on its histological features; its situation, rate of growth, and other clinical features must also be taken into consideration. It cannot be too emphatically stated that there is no hard and fast line between innocent and malignant growths. There is an indefinite transition from one to the other, and some tumours occupy an intermediate position between the two. The possibility of the transformation of a benign into a malignant tumour must be admitted. Such a transformation implies a change in the structure of the growth, and has been observed especially in fibrous and cartilaginous tumours, in tumours of the thyroid gland, and in uterine fibroids. The alteration in character may take place under the influence of injury, prolonged or repeated irritation, incomplete removal of the benign tumour, or the altered physiological conditions of the tissues which attend advancing years.

**Varieties of Tumours.**—In the following description tumours are classified on an anatomical basis, taking in order first the connective-tissue group and subsequently those which take origin in epithelium.

### Innocent Connective-tissue Tumours.

**Lipoma.**—A lipoma is a tumour composed of fat resembling that normally present in the body. The commonest variety is the *subcutaneous lipoma*, which grows from the subcutaneous fat, and forms a soft, irregularly lobulated tumour (Fig. 42). The fat is arranged in lobules separated by connective-tissue septa which are continuous with the capsule surrounding the tumour, and with the overlying skin, which becomes dimpled or puckered when an attempt is made to pinch it up. As the fat is almost fluid at the body temperature, apparent fluctuation can usually be detected in the swelling. These tumours vary greatly in size, occur at all ages, grow very slowly, and, while generally solitary, are sometimes *multiple* and occasionally bilaterally *symmetrical*. They are most commonly met with on the shoulder, buttock, or back. In certain situations, such as the thigh and perineum, they tend to become pedunculated.

A fatty tumour is to be diagnosed from a cold abscess and

from a cyst. The distinguishing features of the lipoma are the tacking down and dimpling of the overlying skin, and the lobulation of the tumour which is recognised when it is pressed upon with the flat of the hand.

The treatment consists in dividing the skin and capsule over the tumour and shelling it out. Care must be taken that none of the outlying lobules are detached and left behind. If the overlying skin is closely adherent, it should be removed along with the tumour.

In the neck, axilla, pubic region and elsewhere, a diffuse overgrowth of the subcutaneous fat is sometimes met with, forming large symmetrical tumour-like masses, known as a *diffuse lipoma.* As this is not, strictly speaking, a tumour, the term *diffuse lipomatosis* is to be preferred. If causing disfigurement the swelling may be removed, but complete extirpation is usually impossible, as the mass is not encapsulated (Fig. 43).



FIG. 42.—Subcutaneous Lipoma.

*Lipomata in other Situations.*—The *periosteal lipoma* is usually of congenital origin, and is most often met with in the hand; it forms a projecting lobulated tumour which, when situated in the palm, may resemble an angioma or a lymphangioma. The *subserous lipoma* may arise from the extra-peritoneal fat in the posterior abdominal wall, in which case it tends to grow forwards between the layers of the mesentery and to give rise to a large abdominal tumour; or it may grow from the extra-peritoneal fat in the anterior abdominal wall and protrude from one of the normal openings or through an abnormal opening in the parietes, constituting a *fatty hernia. Subsynovial lipomata* grow from the fat surrounding the synovial membrane of a joint, and may project into its interior and give rise to the symptoms of loose body. Lipomata are also met with growing from the adipose connective tissue *between or in the substance of muscles*, and when situated beneath the deep fascia the characteristic signs are obscured and a differential diagnosis may be difficult or impossible. It may be differentiated from a cold abscess by puncture with an exploring needle.

**Xanthoma.**—A xanthoma is a tumour composed of connective-tissue cells containing a granular yellow pigment. It occurs in

the skin, especially of the eyelids, in the form of raised yellow patches which tend to increase in size and fuse with each other. It is occasionally met with in other parts of the body as a tumour, it may be as large as a fist, and involving not only the skin but the underlying soft parts. The tumour tissue is soft in consistence, and on section presents a brilliant orange or saffron colour.

Xanthoma may affect several generations of the same family. When it develops after puberty, it is nearly always associated with chronic jaundice. The tumour-like form of xanthoma may become disseminated throughout the body after the manner of sarcoma.



Fig. 43.—Diffuse Lipomatosis of Neck.

**Chondroma** (Fig. 44).—A chondroma is a tumour mainly composed of cartilage. Processes of vascular connective tissue pass in between the nodules of cartilage composing the tumour from the fibrous capsule which surrounds it. On section it is usually of a greyish-blue colour and semi-translucent. The tumour is firm and elastic in consistence, but certain portions may be as hard as bone from calcification or ossification, while other portions may be soft and fluctuating as a result of myxomatous degeneration and liquefaction. These tumours grow slowly and painlessly, and in the course of their growth may surround nerves and arteries without injuring them (Fig. 237). They may cause

a deep hollow in the bone from which they originate. All intermediate forms between the innocent chondroma and the malignant chondro-sarcoma are met with. Chondromata may



Fig. 44.—Chondroma growing from infra-spinous fossa of Scapula.
(Specimen in Sir Patrick Heron-Watson's collection.)

occur in a multiple form, especially in relation to the phalanges and metacarpal bones (Fig. 236). When growing in the interior of a bone a chondroma causes a spindle-shaped enlargement of its shaft, which in the case of a phalanx or metacarpal

bone may resemble a tuberculous or syphilitic inflammation of the bone (dactylitis).

*Treatment.*—In those projecting from the surface of a bone, both the tumour and its capsule should be removed. If in the interior, a sufficient amount of the cortex should be removed to allow of the tumour being scraped out, and care must be taken that no nodules of cartilage are left behind. In multiple chondromata of the hand, when the fingers are crippled and useless, the question of amputation may have to be considered. When a cartilaginous tumour takes on active growth, it must be treated as malignant.

The chondromata that are met with at the ends of the long bones in children and young adults, form a group by themselves. They are usually related to the epiphysial cartilage, and it was suggested by Virchow that they take origin from unaltered islands of cartilage in the interior of the bone which have not been used up in the process of ossification. They are believed to occur most frequently in those who have suffered from rickets in early life. They tend to undergo ossification concurrently with the epiphysial cartilage from which they take origin, and constitute what are known as *cartilaginous exostoses*. These are sometimes met with in a multiple form, and may occur in several generations of the same family.

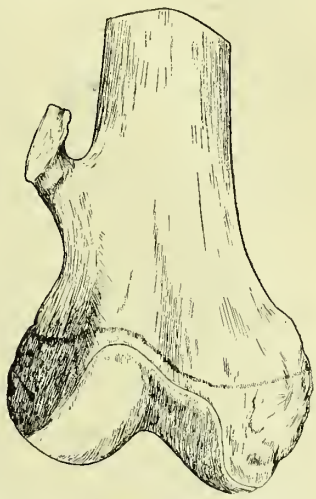


FIG. 45.—Cancellous Osteoma of lower end of Femur, from a patient aged 17.

Cartilaginous tumours in the parotid, submaxillary gland, or testicle are usually chondro-sarcomata.

**Osteoma.**—An osteoma is a tumour composed of bony tissue and originating from the skeleton. Two varieties are recognised —the spongy or cancellous, and the ivory or compact. The common *spongy* or *cancellous osteoma* is really an ossified chondroma, and is met with chiefly at the ends of the long bones of the limbs (Fig. 45). From the fact that it projects from the surface of the bone it is often spoken of as an *exostosis*. It grows very slowly, and rarely causes any discomfort unless it

presses upon a nerve-trunk. The Röntgen rays show a dark shadow corresponding to the ossified portion of the tumour, and continuous with that of the bone from which it is growing. Operative interference is only indicated when the tumour is giving rise to inconvenience. It is then removed, its base or neck being divided by means of the chisel.

The bony outgrowth from the terminal phalanx of the great toe—known as the *subungual exostosis*—is described and figured on page 378.

*The ivory* or *compact osteoma* is composed of dense, compact bone, and usually grows from the bones of the skull. It is generally sessile and solitary, and may grow into the interior of the skull, into the frontal sinus, into the cavity of the orbit or nose, or may fill up the external auditory meatus.

Bony formations sometimes occur in muscles and tendons, especially at their points of attachment to the skeleton, and are described with the diseases of muscles.

**Odontoma.**—An odontoma is a tumour composed of dental tissues in varying proportions and different degrees of development, arising from teeth-germs or from teeth still in process of growth (Bland Sutton). Odontomata resemble teeth in so far that during their development they remain hidden below the mucous membrane and give little or no evidence of their existence. There then succeeds, usually between the twentieth and twenty-fifth years, an eruptive stage, which is often attended with suppuration, and this may be the means of drawing attention to the tumour. Following Bland Sutton, we may distinguish several varieties of odontoma according to the part of the tooth-germ concerned in their formation.

*Epithelial odontomata* are derived from persistent portions of the epithelium of the enamel organ, and constitute multilocular cystic tumours which are chiefly met with in the lower jaw. The cystic spaces of the tumour contain a brownish glairy fluid. These tumours have been described by Eve under the name of multilocular cystic epithelial tumours of the jaw.

The *follicular odontoma*, formerly known as a *dentigerous cyst*, is derived from the distension of a tooth follicle. It constitutes a cyst which contains a viscid fluid, and an imperfectly formed tooth is often found embedded in its wall. The cyst usually forms in relation to one of the permanent molars, and may attain considerable dimensions.

The *fibrous odontoma* is the result of an overgrowth of fibrous tissue surrounding the tooth sac, which encapsulates the tooth and prevents its eruption. The thickened tooth sac is

usually mistaken for a fibrous tumour until the tooth is recognised in its interior after removal.

*Composite Odontomata.*—This is a convenient term to apply to certain hard dental tumours which are met with in the jaws, and consist of enamel, dentine, and cement. They are to be regarded as being derived from an abnormal growth of all the elements of a tooth germ, or of two or more tooth germs, indiscriminately fused with one another. They may appear in childhood, and form smooth, unyielding tumours, often of considerable size, replacing the corresponding permanent teeth. Many examples of this variety of odontoma, growing in the nasal cavity or in the antrum, have been erroneously regarded as osteomata even after removal. They may cause a purulent discharge, and in some cases have been spontaneously extruded after sloughing of the overlying soft parts.

On section, the tumour is usually laminated, and is seen to consist mainly of dentine with a partial covering of enamel and cement.

*Diagnosis.*—Odontomata are often only diagnosed after removal. When attended with suppuration the condition has been mistaken for disease of the bone. Fibrous odontomata have been mistaken for sarcomata, and portions of the jaw removed unnecessarily. Any circumscribed tumour of the jaw, particularly when met with in a young adult, should suggest an odontoma.

*Treatment.*—The solid varieties of odontoma can usually be shelled out after dividing the overlying soft parts. In the follicular variety, it is usually sufficient to excise a portion of the wall, scrape out the interior, and remove the tooth if it is present. The cavity is then packed with gauze, and allowed to heal from the bottom.

**Fibroma.**—A fibroma is a tumour composed of fibrous connective tissue. A distinction may be made between the *soft fibroma*, which is comparatively rich in cells and blood-vessels, and in which the fibres are arranged loosely; and the *hard fibroma*, which is almost entirely composed of closely packed bundles of fibres often arranged in a concentric fashion around the blood-vessels. The cut surface of the soft fibroma presents a pinkish-white, fleshy appearance resembling the slowly growing forms of sarcoma; that of a hard fibroma presents a dry, glistening appearance, aptly compared to watered silk. The soft variety grows much more rapidly than the hard. In certain fibromata—in those, for example, which grow from the periosteum of the base of the skull and project into the naso-pharynx—the

blood-vessels are dilated into sinuses and have no proper sheaths. They therefore tend to remain open when divided and to bleed excessively. Transition forms between soft fibromata and sarcomata are met with, so that in operating for their removal it is safer to take away the capsule along with the tumour.

The skin—especially the skin of the buttock—is one of the favourite seats of fibromata, and they may occur in a multiple form. They are met with also in the subcutaneous and intermuscular cellular tissue, and in the abdominal wall, where they sometimes attain considerable dimensions. The fibrous overgrowths in the skin known as keloid and molluscum fibrosum, and those met with in the sheaths of nerves, are described elsewhere. Fibroid tumours of the uterus are described with myomata.

*Diffuse fibroma* or *Fibromatosis*, analogous to lipomatosis, is met with in the connective tissue of the skin and sheaths of nerves, and constitutes one form of neuro-fibromatosis.

**Myxoma.**—A myxoma is composed of tissue similar to that found in the umbilical cord. The tumour is characterised by its soft, gelatinous, semifluid consistence. The pure myxoma is extremely rare, and occurring, as it does, chiefly in the subcutaneous and intermuscular connective tissue, it resembles clinically the lipoma. Myxomatous tissue is, however, frequently found in other connective-tissue tumours as a result of myxomatous degeneration. This is specially observed in cartilaginous tumours and in sarcomata. Myxomatous tissue is usually a prominent constituent of the "innocent parotid tumour." Mucous polypi of the nose, which are often described as myxomata, are merely pendulous processes of œdematous mucous membrane.

**Myeloma.**—A myeloma is a tumour composed of large multinuclear giant cells surrounded by round and spindle cells. The cut surface of the tumour usually presents a deep red or maroon colour. While occasionally met with in tendon sheaths and bursæ, the myeloma occurs most frequently in the cancellous tissue at the ends of the long bones (Fig. 238). Although formerly classified with the sarcomata, it is quite the exception for a myeloma to present malignant features, and it can usually be extirpated by local measures without fear of recurrence. The method of removal varies with its situation and is considered elsewhere.

**Myoma.**—A myoma is a tumour composed of non-striped muscle fibres. Pure myomata are very rare. They are met with in organs possessed of non-striped muscle, such as the stomach, intestine, urinary bladder, and prostate; in the uterus, which is the most common situation for these tumours, as

they contain a considerable admixture of fibrous tissue, they are known as *fibroids* or *fibro-myomata* (Fig. 46). They present on section a fasciculated appearance which may resemble that of a section of balls of cotton. They are encapsulated and vascular tumours, and they frequently attain a large size. They may be single or multiple. While they may occasion neither inconvenience nor suffering, they frequently give rise to profuse hæmorrhage from the uterus, and they may cause serious symptoms by pressing injuriously on the ureters or the intestine, or by complicating pregnancy and parturition.

The **Rhabdomyoma** is an extremely rare form of tumour met with in the kidney, uterus, and testicle. It contains striped muscle fibres, and is supposed to originate from a residue of muscular tissue which has become sequestrated during development.



Fig. 46.—Fibro-myoma of Uterus.

(Anatomical Museum of the University of Edinburgh.)

**Glioma.**—A glioma is a tumour composed of neuroglia. It is met with exclusively in the central nervous system, retina, and optic nerve. It is a slowly growing, soft, ill-defined tumour which displaces the adjacent nerve centres and nerve tracts, and is liable to become the seat of hæmorrhage and to give rise to pressure symptoms. The glioma of the retina tends to grow into the vitreous humour and to perforate the globe. It is usually of the nature of a glio-sarcoma and is highly malignant.

**Endotheliomata** constitute a multiform group of new growths which take origin from the endothelium of lymphatic vessels and spaces, of blood-vessels, serous cavities, bursæ, and of the synovial membrane of joints and tendon sheaths. They show great variation in type, partly because of the number of different kinds of endothelium from which they are derived, and partly because the new connective tissue which is formed is liable to undergo transformation into hyaline, cartilaginous or myxomatous tissue. They may be soft or hard, solid or cystic, diffuse or circumscribed; they grow very slowly, and are almost

invariably innocent, although local recurrence has been occasionally observed. The best-known example of endothelioma is the "mixed tumour" met with in the salivary glands and palate.

*Angioma*, *lymphangioma*, *neuroma*, and *lymphoma* are described with the diseases of the individual tissues.

## Malignant Connective-tissue Tumours—Sarcomata.

The term sarcoma is applied to any connective-tissue tumour which exhibits malignant characters. The essential structural feature is the predominance of the cellular elements over the intercellular substance or stroma, in which respect a sarcoma resembles the connective tissue of the embryo. The typical sarcoma consists chiefly of immature or embryonic connective tissue. While these tumours may grow from any of the connective tissues of the body, they originate most frequently from fascia, intermuscular connective tissue, periosteum, bone marrow, and skin. They form rounded or nodulated tumours which appear to be encapsulated, but the capsule merely consists of the condensed surrounding tissues and usually contains sarcomatous elements, because of the tendency of the cells of the tumour to infiltrate the adjacent tissues. The consistence of the tumour depends on the nature and amount of the stroma, and on the presence of degenerative changes. The softer medullary forms of sarcoma are composed almost exclusively of cells; while the harder forms—such as the fibro-, chondro- and osteo-sarcoma—are provided with an abundant stroma and are relatively poor in cells. Degenerative changes may produce areas of softening or liquefaction which form cystic cavities in the interior of the tumour. The colour depends on the amount of blood in the tumour and on the results of degeneration. The blood-vessels constitute a prominent feature in sarcomata, and although sometimes possessed of a definite wall, they are usually represented by mere chinks or spaces between the cells of the tumour. This peculiarity accounts for the facility with which hæmorrhage takes place into the substance of the tumour, the persistence of the bleeding when the tumour is incised or ulcerates through the skin, and the readiness with which the sarcomatous cells may be carried off into the circulating blood. Sarcomata are devoid of lymphatics, and unless originating in lymphatic structures—for example, in the tonsil—they rarely infect the lymphatic glands. Sarcomata usually infect distant parts through the blood-stream. Minute portions of the tumour

grow into the small veins, and becoming detached, are transported by the blood-current to distant organs, where they are arrested in the capillaries and give rise to independent secondary growths. These are most frequently situated in the lungs, except when the primary growth lies within the territory of the portal circulation, in which case they occur in the liver. The secondary growths closely resemble the parent tumour. Sarcoma may invade an adjacent vein on such a scale that if the invading portion become detached it may constitute a dangerous embolus. This may be observed in renal sarcoma, the growth taking place along the renal vein until it projects into the inferior vena cava.

In their growth sarcomata compress and destroy neighbouring parts, surround vessels and nerves, and may lead to destruction of the skin, either by invading it or more commonly by causing sloughing from pressure. Once the skin is broken the tumour fungates through the opening. Inflammatory and suppurative changes may take place in sarcomata as a result of pyogenic infection. They vary greatly in malignancy, especially as regards rapidity of growth and capacity for dissemination. Certain of them, such as the so-called "recurrent fibroid of Paget," grow comparatively slowly, and are only malignant in the sense that they tend to recur locally after removal. Others, again—especially the more cellular tumours—grow with extreme rapidity, and are early disseminated throughout the body, resembling in these respects the most malignant forms of cancer. Sarcomata occur at all ages. They are usually solitary in the first instance, although it is stated that primary multiple growths are occasionally met with in the skin and in the bones.

Many varieties of sarcomata are recognised according to the structural peculiarities of the growth. Thus, according to the size and character of the cells, we have the *small round-celled* and the *large round-celled* sarcomata, the *small* and *large spindle-celled* sarcomata, the *giant-celled* and the *mixed-celled* sarcomata. The *lympho-sarcoma* presents a structure similar to that of lymph follicular tissue, and the *alveolar sarcoma*, an arrangement of cells in alveoli resembling that seen in cancers. When there is a considerable amount of intercellular fibrous tissue the tumour is called a *fibro-sarcoma*.

The term *lymphangio-sarcoma* is applied when the cells of the tumour are derived from the endothelium of lymphatic spaces and vessels. The *angio-sarcomata* are those in which blood-vessels form a prominent element in the structure of the tumour. They are sometimes derived from innocent angiomata, and they may

be so vascular as to pulsate like an aneurysm and yield a blowing murmur on auscultation. The *glio-sarcoma*, *myxo-sarcoma*, *chondro-sarcoma*, and *myo-sarcoma* are mixed forms which usually develop in already existing innocent tumours. The *osteo-sarcoma* is characterised by the formation in the tumour of true bone by a process of ossification, the medullary spaces being occupied by sarcomatous cells in place of marrow. The *osteoid sarcoma* is characterised by the formation of a tissue resembling bone but deficient in lime salts, and the *petrifying sarcoma* by the formation of calcified areas in the stroma. These varieties, although met with chiefly in the skeleton, may occur in the soft tissues such as muscle, and in such organs as the mamma. The pigmented varieties include the *chloroma*, which is of a light-green colour, and the *melanotic sarcoma*, which is brown or black. The *psammoma* is a sarcoma containing a material resembling sand, and it is chiefly met with in the membranes of the brain.

*Diagnosis of Sarcoma.*—Sarcomata are to be differentiated from inflammatory swellings such as result from tubercle and syphilis, from innocent tumours, and from cancers. The points on which the diagnosis is founded are discussed with the different tissues and organs.

*Treatment.*—The removal of the tumour by operation is the only satisfactory method of treatment, but in order to be successful it must be undertaken before dissemination has taken place. It is absolutely essential to remove a considerable area of healthy tissue beyond the apparent margin of the growth. In tumours which approach the surface of the body, the overlying skin should also be removed. If it is impossible to remove the tumour completely, or if there is already evidence of secondary growths, it is better to abstain from operative interference unless there are special indications to be fulfilled—such as the relief of pain or the arrest of hæmorrhage.

In inoperable cases recourse has been had to the injection of the toxins of the streptococcus of erysipelas. This treatment is based on the fact that an intercurrent attack of erysipelas has occasionally resulted in the disappearance of a sarcoma. Coley's fluid, which consists of a sterilised culture of the streptococcus of erysipelas and the bacillus prodigiosus, is the injection usually employed. The two organisms are grown together and the culture is then sterilised by heat. A dose, which varies in amount with the virulence of the culture employed, is injected every second or third day into the subcutaneous tissue at a little distance from the tumour. Each injection is followed by a reaction attended with fever, nausea, and pain; the treatment

is in consequence very distressing to the patient. In successful cases, the tumour decreases in size, becomes less painful, and may eventually disappear. This result is said to have been obtained in 16 per cent. of the cases subjected to the treatment, the best results being obtained in spindle-celled tumours (Coley). The effect of the toxins is to cause degeneration of the cellular elements of the growth, which then become absorbed. Inflammation and sloughing, when they occur, are septic complications which ought to be avoided. Should no improvement manifest itself after a three weeks' course of the treatment, it should be abandoned. Encouraging results in inoperable cases have also been obtained by the use of the Röntgen rays.

## Epithelial Tumours.

An excessive and erratic growth of epithelium constitutes the essential and distinguishing feature of the tumours in this class. The innocent forms are the papilloma and the adenoma; the malignant, the carcinomata or cancers.

**Papilloma.**—Papillomata are tumours which project from a cutaneous or mucous surface, and consist of a central axis of vascular fibrous tissue with a covering of epithelium which resembles that of the surface from which the tumour grows. In the papillomata of the skin—commonly known as *warts*—the covering consists of epidermis; in those growing from mucous surfaces it consists of the epithelium covering the mucous membrane. When the surface epithelium projects as filiform processes, the tumour is called a *villous papilloma*, the best-known example of which is met with in the urinary bladder. Papillomatous growths are also met with in the larynx, in the ducts of the breast—the so-called duct papilloma—and in the interior of certain cystic tumours of the breast and of the ovary. Although papillomata are innocent, when subjected to irritation they may become the starting-point of cancer. The clinical features and treatment of the various forms of papillomata are considered under the individual tissues and organs.

**Adenoma.**—An adenoma is a tumour constructed on the type of, and growing in connection with, a secreting gland. In the substance of such glands as the mamma, parotid, thyroid, and prostate, adenomata are met with as encapsulated tumours. When they originate from the glands of the skin or of a mucous membrane, they tend to project from the surface, and sometimes form pedunculated tumours or polypi.

Adenomata may be single or multiple, and they vary in size from a pea to an adult human head. The tumour is seldom composed entirely of gland tissue; it usually contains a considerable proportion of fibrous tissue, and is called a *fibro-adenoma*. When it contains myxomatous tissue it is called a *myxo-adenoma*, and when the gland spaces of the tumour become distended with accumulated secretion, a *cystic adenoma*,

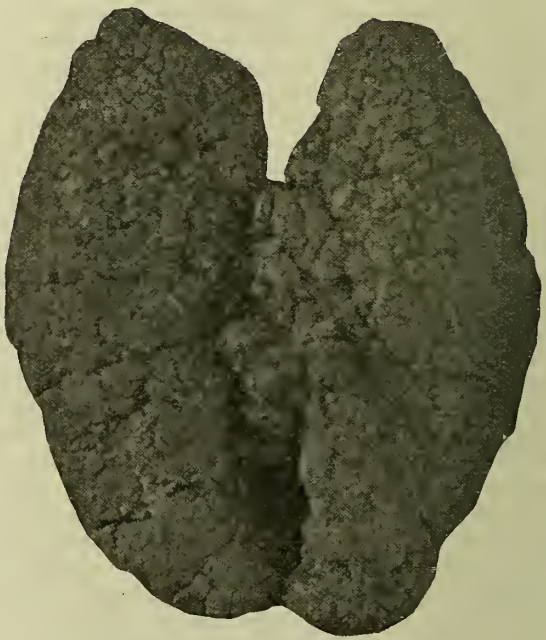


Fig. 47.—Papilloma of the Vulva.

the best examples of which are met with in the mamma and ovary. A characteristic feature of the cystic variety is the tendency the tumour tissue exhibits to project into the interior of the cysts, constituting what are known as *intracystic growths*. They are essentially innocent, and when removed by operation, show no tendency to recur. At the same time, transition forms between adenoma and carcinoma are met with, especially in the intestine, and these should be treated on the same lines as cancer.

## Carcinomata or Cancers.

A cancer is a malignant tumour which originates in epithelium. The cells which form the essential constituent of a cancer are derived by proliferation from already existing epithelium, and they invade the sub-epithelial connective tissue in the form of simple or branching columns. These columns are enclosed in spaces—termed alveoli—which are probably dilated lymphatic spaces, and which communicate freely with the lymphatic vessels. The cells composing the columns and filling the alveoli vary with the character of the epithelium in which the cancer originates. The malignancy of cancer depends on this capacity which the epithelium has of invading the tissues in its neighbourhood, and on the capacity of the cells, when transported elsewhere by the lymph or blood-stream, of giving rise to secondary growths.

Cancer may arise on any surface covered by epithelium or in any of the secreting glands of the body, but it is much more common in some situations than in others. It is very frequently met with, for example, in the skin, in certain portions of the alimentary canal, in the breast, the uterus, and the external genitals; less frequently in the gall-bladder, larynx, thyroid, prostate, kidney, and urinary bladder.

Cancers increase in frequency as life advances. Cancers of the stomach appear and attain a maximum frequency earlier than cancers of the skin; cancers of the uterus and mamma are more frequent towards the decline of reproductive activity than in the later years of life. Tissues appear to be most liable to cancer when, having attained maturity, they enter upon the phase of decadence or involution, and this phase is reached by different tissues at different periods in the life of the organism. It is not so much, therefore, the age of the person in whom it occurs, as the age of the tissue in which it arises, that determines the maximum incidence of cancer.

A cancer may appear as a papillary growth from a mucous or a skin surface, as an imperfectly circumscribed nodule in the substance of an organ, or as a diffuse thickening of a tubular structure such as the intestine or stomach. The absence of definition in cancerous tumours explains the difficulty in completely removing them by surgical measures, and has led to the practice of complete extirpation of cancerous organs wherever this is possible. The boundaries of the affected organ are, moreover, frequently transgressed by the tumour, and the epithelial infiltration implicates the surrounding parts. In cancer

of the breast, for example, the disease often extends to the adjacent skin, fat, and muscle; in cancer of the lip or tongue, to the lower jaw; in cancer of the uterus or intestine, to the investing peritoneum. In addition to its tendency to infiltrate adjacent tissues and organs, cancer is also liable to give rise to secondary growths. These are most often met with in the nearest lymphatic glands: those in the neck, for example, becoming infected from cancer of the lip, tongue, or throat; those in the axilla, from cancer in the breast; those along the curvatures of the stomach, from cancer of the pylorus; and those in the groin, from cancer of the external genitals. In lymphatic vessels the cancer cells may merely accumulate so as to fill the lumen and form indurated cords, or they may proliferate and give rise to secondary nodules along the course of the vessels. When the lymphatic network in the skin is diffusely infected the appearance is either that of a multitude of secondary nodules, or of a diffuse thickening, so that the skin comes to resemble coarse leather. On the wall of the chest this condition is known as *cancer en cuirasse*. Although the cancer cells very constantly attack the walls of the adjacent veins and spread into their interior at an early period, secondary growths due to dissemination by the blood-stream rarely show themselves clinically until late in the course of the disease. It is probable that many of the cancer cells which are carried away in the blood or lymph stream undergo necrosis and fail to give rise to secondary growths. Secondary growths present a faithful reproduction of the structure of the primary tumour. Apart from the lymphatic glands, the chief seats of secondary growths are the liver, lungs, serous membranes, and bone marrow.

The tumour tissue may undergo necrosis, and when the overlying skin or mucous membrane gives way an ulcer is formed. The margins of a *cancerous ulcer* are made up of tumour tissue which has not broken down. Usually they are irregular, nodularly thickened or indurated; sometimes they are raised and crater-like. The floor of the ulcer is smooth and glazed or occupied by necrosed tissue, and the discharge is watery and blood-stained, and as a result of putrefactive changes may become offensive. Hæmorrhage is rarely a prominent feature, but the discharge of blood may constitute a symptom of considerable importance in cancer of internal organs such as the rectum, the bladder, or the uterus.

Regarding *the causes of cancer*, much attention has been directed in recent years to the possibility of its origin from infection with micro-organisms. It must be conceded, however, that

no one has been able to originate an unequivocal new growth by the agency of any parasite. It is a striking fact that at a certain stage of its growth cancerous tissue is essentially similar to the tissue of the embryo. There are a number of conditions which favour the development of cancer, such as inheritance, age, environment, prolonged irritation, and many others. These cannot, however, be regarded as essential causes of cancer; some other factor would appear to be required, but what that factor is still remains unknown.

While there are isolated instances recorded of the communication of cancer from one person to another, the difficulties which attend the artificial transference of new growths in general demonstrate the important fact that cancer is neither contagious nor infectious.

*The prognosis* largely depends on the particular variety of cancer and on its situation. Certain varieties—such as the atrophic cancer of the breast which occurs in old people, and some forms of cancer in the rectum—are so indolent in their progress that they can scarcely be said to shorten life; while others—such as the softer varieties of mammary cancer occurring in young women—are among the most malignant of tumours. The mode in which cancer causes death depends to a large extent upon the situation of the tumour. In the gullet or stomach, for example, it usually causes death by starvation; in the larynx or thyroid, by suffocation; in the intestine, by obstruction of the bowels; in the uterus, prostate, and bladder, by hæmorrhage, or by implication of the ureters and kidneys. Independently of their situation, however, those tumours frequently cause death by giving rise to a progressive impairment of health known as the *cancerous cachexia*, a condition which is due to the continued absorption of poisonous products from the tumour. The patient loses appetite, becomes emaciated, pale, and feverish, and gradually loses strength until he dies, apparently from exhaustion.

*Treatment.*—The only treatment of cancer that affords a prospect of cure is removal by surgical measures. "If carcinomatous disease is to be rooted out, its mode of spread by means of the lymphatic vessels must be borne in mind, and as this occurs at an early stage, and is not evident on examination, a very wide area must be included in the operation. The organ from which the original growth springs should, if practicable, be altogether removed, because its lymphatic vessels generally communicate freely with each other, and secondary deposits have probably already taken place in various parts of it. In addition,

the nearest chain of lymphatic glands must also be removed, even though they may not be noticeably enlarged, and in some cases—in cancer of the breast, for example—the intervening lymphatic vessels should be removed at the same time" (Watson-Cheyne).

The treatment of cancer by other than operative methods has received a great deal of attention within recent years. Various anti-cancerous sera have been introduced but have not yielded the results claimed on their behalf. The repeated application

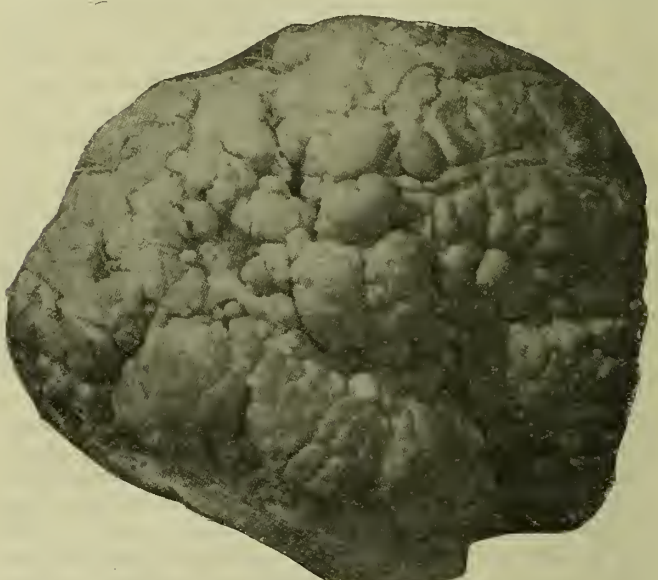


FIG. 48.—Squamous Epithelioma of the Scalp.

of the Röntgen rays has proved to be of great value in the treatment of cancers situated in or near the skin and accessible mucous surfaces. In rodent cancer the rays are definitely curative and get rid of the disease with less disfigurement than results from operative methods. In squamous epithelioma a cure is much less certain, and in the cutaneous nodules of cancer secondary to disease in the breast the influence of the rays is rather to retard or inhibit their growth than to cause their disappearance. In the case of cancerous ulcers the rays tend to relieve pain, to diminish discharge and hæmorrhage, and may

thereby prolong life. Deeply seated cancers are not influenced by the rays.

### Varieties of Cancer.

Different varieties of cancer are distinguished according to the character and arrangement of the epithelial cells concerned in their formation.

The *squamous epithelial cancer* or *epithelioma* originates from surfaces covered by squamous epithelium, such as the skin, and the mucous membrane of the mouth and gullet, larynx, bladder, and external genitals. The epithelial columns which constitute the cancer retain the characters of squamous epithelium, and being confined within the lymphatic spaces of the sub-epithelial connective tissue, they become compressed and undergo a horny change. This results in the formation of concentrically laminated masses known as "cell nests" or "epithelial pearls."

The clinical features are usually those of a slowly growing, indurated. tumour which nearly always ulcerates; there is a characteristic induration of the edges and floor of the ulcer, and its surface is often covered with warty or cauliflower-like outgrowths (Fig. 48). The infection of the lymphatic glands is remarkably early and constant, and constitutes the most dangerous feature of the disease; the secondary growths in the glands exhibit the characteristic induration, and may themselves break down into ulcers.

Epithelioma frequently originates in long-standing ulcers or sinuses, and in scars, and probably results from the displacement and sequestration of epithelial cells during the process of cicatrisation.

The *columnar epithelial cancer* or *columnar epithelioma* originates in mucous membranes covered with columnar epithelium, and is chiefly met with in the stomach and intestine. It is sometimes described as a *malignant adenoma*, because of its close structural resemblance to the innocent adenoma. Its malignancy is shown by the proliferating epithelium invading the other coats of the stomach or intestine, and by the fact that it gives rise to secondary growths.

*Glandular carcinoma* originates in glandular organs, such as the breast, and in the glands of mucous membranes and skin. The epithelial cells are not arranged on any definite plan, but are closely packed in irregularly shaped alveoli. If the alveoli are large and the intervening stroma is scanty and delicate, the tumour is soft and brain-like, and is described as a *medullary* or *encephaloid cancer*. If the alveoli are small and the intervening

stroma is abundant and composed of dense fibrous tissue, the tumour is hard, and is known as a *scirrhus cancer*—a form which is most frequently met with in the breast. If the cells undergo degeneration and absorption and the stroma contracts, the tumour becomes still harder, and tends to shrink or contract and to draw in the surrounding parts, in the breast leading to retraction of the nipple and overlying skin, and in the stomach and intestine to narrowing of the lumen. When the cells of the tumour undergo colloid degeneration, a rare form of cancer — *colloid cancer* — is produced. Melanin pigment is formed in relation to the cells and stroma of certain epithelial tumours, giving rise to the *melanotic cancer* (Figs. 85, 86). *Cystic carcinomata* are those in which cyst-like spaces are formed in the tumour by the accumulation of the secretion of the epithelial cells, or as a result of their degeneration. They are met with chiefly in the breast and ovary, and resemble very closely the cystic adenomata, only they tend to infect their surroundings and to give rise to secondary growths.

*Rodent cancer* originates in the glands of the skin, and presents a special tendency to break down and ulcerate on the surface (p. 371). It very rarely infects the adjacent lymphatic glands.

**Dermoids.**—A dermoid is defined as a tumour containing skin or mucous membrane and occurring in a situation where these tissues are not met with under normal conditions.

*Skin dermoids*, or *Derma-cysts* as they have been called by Askanazy, arise from portions of epiblast sequestrated in the course of development. When, during embryonic life, coalescence is taking place between two cutaneous surfaces, a portion of epiblast becomes detached or sequestrated, and remains embedded until at some future period it becomes the starting-point of a dermoid. Such a dermoid usually presents the form of a globular cyst, the wall of which consists of skin and the contents of turbid fluid containing desquamated epithelium, fat droplets, cholesterin crystals, and detached hairs. Delicate hairs may also be found projecting from the epithelial lining of the cyst. Such dermoids occur on the trunk in situations where the lateral halves of the body coalesce during development, but they are more commonly met with on the face and neck in the situation of the various clefts and fissures of the embryo. Faulty coalescence of the cutaneous covering of the back occurs most frequently over the lower sacral vertebræ, giving rise to small congenital recesses, known as post-anal dimples and coccygeal

sinuses. These recesses are lined with skin which is furnished with hairs, sebaceous and sweat glands. If the external orifice becomes occluded, there results a dermoid cyst.

*Tubulo-dermoids* arise from embryonic ducts and passages which are normally obliterated at birth; they are illustrated by those related to the thyro-glossal duct (lingual dermoids), the post-anal gut (rectal and post-rectal dermoids), and the branchial clefts (branchial dermoids). Tubulo-dermoids present the same structure as skin dermoids, save that in so far as they arise from a tube lined by mucous membrane this takes the place of skin in the wall of the cyst, and the contents are derived from the pent-up secretion of mucous glands.

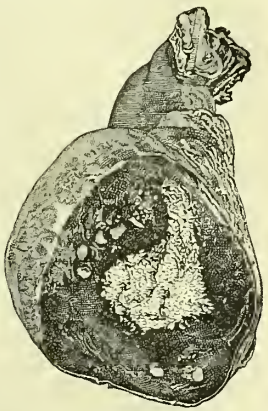


Fig. 49.—Dermoid Cyst of Ovary showing Teeth in its Interior.

*Clinical Features.*—Although dermoids are of congenital origin, they are rarely evident at birth, and may not give rise to visible tumours until puberty, when the skin and its appendages become more active, or even not till adult life. Superficial dermoids, such as those met with at the outer angle of the orbit, form rounded, definitely limited tumours, over which the skin is freely movable. They are usually adherent to the deeper parts, and when situated over the skull they may be lodged in a depression or actual gap in the bone. Sometimes the cyst becomes infected and suppurates, and finally ruptures on the surface. This may lead to a natural cure, or a persistent sinus may remain. Dermoids more deeply placed, such as those within the thorax, or those situated between the rectum and sacrum, give rise to considerable difficulty in diagnosis, and their nature is seldom recognised until the character of the contents—particularly hairs—supplies the clue. The literature of dermoid cysts is full of accounts of puzzling tumours met with in all sorts of situations.

The treatment consists in removing the cyst. When it is impossible to remove the whole of the lining membrane by dissection, the portion which is left should be destroyed with the cautery.

*Ovarian Dermoids.*—Dermoids are not uncommon in the ovary (Fig. 49). They usually take the form of unilocular or multilocular cysts, the wall of which contains skin, mucous

membrane, hair follicles, sebaceous, sweat, and mucous glands, nails, teeth, nipples, and mammary glands. The cavity of the cyst usually contains a pultaceous mixture of shed epithelium, fluid fat, and hair. If the cyst ruptures, the epithelial elements are diffused over the peritoneum, and may give rise to secondary dermoids.

The histogenesis of ovarian dermoids has given rise to considerable difference of opinion. By many they are regarded as taking origin from the epiblast, and as containing only epiblastic structures; recent observations, and especially those of Askanazy, would appear to show that they may contain tissues derived from all three layers of the embryo, and that no hard and fast line can be drawn between an ovarian dermoid and a teratoma.

The ovarian dermoid appears clinically as an abdominal or pelvic tumour provided with a pedicle; if the pedicle become twisted, the tumour undergoes strangulation, an event which is attended with urgent symptoms, not unlike those of strangulated hernia.

The treatment of the ovarian dermoid consists in removing the tumour by laparotomy.

**Teratoma.**—A teratoma is distinguished from a dermoid not only by its usually containing tissues or structures derived from all of the germinal layers of the embryo, but also by the embryonic character of the tissues, by the greater rapidity of their growth, and by their tendency to give rise to metastases. Teratomata are believed to result from partial dichotomy or cleavage of the trunk axis of the embryo, and are found exclusively in connection with the skull and vertebral column. They include such monstrosities as conjoined twins or parasitic fœtus. They are more commonly met with as irregularly shaped tumours, usually growing from the posterior surface of the sacrum. On dissection, these are found to contain a curious mixture of tissues—bones, skin, and portions of viscera, such as the intestine or liver. The question of the removal of such tumours requires to be considered in relation to the conditions present in each individual case.

## Cysts.[1]

Cysts are usually rounded sacs, the wall being composed of fibrous tissue lined by epithelium or endothelium; the contents are fluid or semi-solid, and vary in character according to the organ or tissue in which the cyst has originated.

[1] Cysts which form in relation to new growths have been considered with tumours.

*Retention and Exudation Cysts.*—*Retention cysts* develop where the duct of a secreting gland is partially obstructed; the secretion accumulates, and the gland and its duct become distended into a cyst. They are frequently met with in secreting organs, such as the mamma, pancreas, salivary glands, mucous and sebaceous glands. Sebaceous cysts or wens are described with diseases of the skin, and other retention cysts with the surgery of their respective regions. *Exudation cysts* arise from the distension of cavities which are not provided with excretory ducts, such as those in the thyroid.

*Implantation cysts* are caused by the accidental implantation of portions of the epidermis into the underlying connective tissue, as may occur in accidental wounds by needles, awls, forks, or thorns. The implanted epidermis proliferates and forms a small cyst. They are met with chiefly on the palmar aspect of the fingers, and vary in size from a split pea to a cherry. The treatment consists in removing them by dissection.

*Parasitic cysts* are produced by the growth within the tissues of cyst-forming parasites, the best known being the tænia echinococcus, which gives rise to the *hydatid cyst.*

The parent worm, the *tænia echinococcus*, inhabits the intestine of the dog, and its ova are passed with the fæces. Having gained entrance to the stomach of the intermediate host, the embryos are liberated; they bore through the wall of the intestine and reach venous and lymphatic channels by which they are distributed throughout the body. When the embryo reaches its destination it loses its hooks, enlarges, becomes converted into a cyst and creates around it the formation of granulation tissue. The wall of the fully formed cyst is composed of an internal granular layer or endocyst; a laminated, elastic outer layer or ectocyst; and an adventitious capsule of fibrous tissue. From the endocyst are formed brood capsules and scolices, the latter representing the heads of the young echinococci, and exhibiting a series of suckers and a row of hooklets. The fluid within the cyst is colourless, usually neutral in reaction, devoid of albumen, and contains a trace of sodium chloride, and other elements which vary with the organ in which the cyst is embedded. The inner layer of the parent cyst frequently gives origin to daughter cysts which may occupy the interior of the parent cyst or lie outside of it, the latter being the usual arrangement in the marrow of bone. Another variety known as the multilocular hydatid is met with chiefly in the liver, the organ which is by far the most common site of hydatid cysts in the human subject.

Regarding the further life-history of hydatids, the living elements of the cyst may die and degenerate, or the cyst may increase in size until it ruptures. As a result of pyogenic infection the cyst may be converted into an abscess.

The *clinical features* of hydatids vary so much with their situation and size that they are best discussed with the surgery of the individual organs. In general it may be said that there is a slow and steady formation of a globular, elastic, fluctuating, painless swelling. Fluctuation is detected when the cyst approaches the surface, and it is then also that percussion may elicit the "hydatid thrill" or fremitus. This thrill is not often obtainable, and in any case is not pathognomonic of hydatids, as it may be elicited in ascites and in tense abdominal or pelvic cysts. Pressure of the cyst upon adjacent structures, and the occurrence of suppuration, are attended with characteristic clinical features.

The *diagnosis* of hydatids will be considered with the individual organs. The disease is more common in Australia and in Iceland than in countries where the association of dogs in the domestic life of the inhabitants is less intimate.

The *treatment* consists in completely excising the cyst, or when this is impracticable, in incising its wall and removing the contents. The question of the exploratory puncture of hydatid cysts is considered in relation to hydatids of the liver.

*Blood cysts* may result from the encapsulation of extravasated blood in the tissues, from hæmorrhage taking place into a pre-formed cyst, or from the saccular pouching of a varicose vein.

*Lymph cysts* may result from contusions in which the skin is forcibly displaced from the subjacent tissues whereby lymphatic vessels are torn across. The cyst is usually situated between the skin and fascia and contains clear or blood-stained serum. At first it is lax and fluctuates readily, later it becomes larger and more tense. In contrast to hæmorrhagic effusions there is little tendency to absorption. The treatment consists in drawing off the contents through a hollow needle and applying firm pressure. These cysts were formerly confused with blood cysts; their true nature was first recognised by Gegenbauer.

Apart from injury, lymph cysts are met with as the result of the distension of lymphatic spaces and vessels (*lymphangiectasis*); and in the lymphangiomata, of which the best-known example is the cystic hygroma or hydrocele of the neck.

## Ganglion.

This term is applied to a cyst filled with a clear jelly or colloid material, and usually met with in the immediate vicinity of a joint.

*The carpal ganglion*—popularly known as a sprained sinew—is met with as a smooth, rounded, or oval swelling on the dorsal aspect of the carpus, usually towards its radial side (Fig. 50). It is situated over one of the intercarpal or other joints in this region, and may appear to be connected with one or other of the extensor tendons. The skin and fascia are movable over the cyst. The cyst varies in size from a pea to a pigeon's egg; having attained its maximum size within a few months, it undergoes no further increase. It becomes tense and more prominent when the hand is flexed towards the palm. Its appearance is usually ascribed to some strain of the wrist—for example, in girls learning gymnastics, or in women after a heavy washing.



Fig. 50.—Carpal Ganglion in a woman aged 25.

It may cause no symptoms beyond the deformity, or it may interfere with the use of the hand, especially in grasping movements and when the hand is dorsiflexed. In females it may give rise to pain which shoots up the arm.

*The tarsal ganglion* is situated on the dorsum of the foot over one or other of the intertarsal joints. It is usually smaller, flatter, and more tense than that met with over the wrist, so that it is sometimes mistaken for a bony tumour. It rarely

causes any symptoms, unless so situated as to be pressed upon by the boot.

*Ganglia in the region of the knee* are usually situated over the interval between the femur and tibia, most often on the outer aspect of the joint and in front of the tendon of the biceps. The swelling, which may attain the size of half a walnut, is tense and hard when the knee is extended, and becomes softer and more prominent when it is flexed. They are met with chiefly in young adult males who follow laborious occupations or who indulge in athletics, and may cause stiffness, discomfort, and impairment of the use of the limb.

Ganglionic cysts are met with in other situations than those described, but they are so rare as not to require separate mention.

Ganglia are to be diagnosed by their situation and physical characters; bursæ, synovial cysts, and new growths are the swellings most likely to be mistaken for them. The diagnosis is sometimes only cleared up by withdrawing the clear, jelly-like contents by means of an exploring needle.

*Pathological Anatomy.*—On dissection, the wall of the cyst is found to consist of dense fibrous tissue closely adherent to or fused with the surrounding tissues. A ganglion cannot be shelled out like a sebaceous cyst. There is no endothelial lining, and the fibrous tissue of the wall is in immediate contact with the colloid material in the interior. The microscopical appearances give the impression that the colloid material is derived by a process of degeneration from the surrounding fibrous connective tissue. In the region of the knee the ganglion is usually multilocular, and consists of a meshwork of fibrous tissue, the meshes of which are occupied by colloid material.

It is often stated that a ganglion originates from a hernial protrusion of the synovial membrane of a joint or tendon sheath into the surrounding tissues. We have not been able to demonstrate any communication between the cavity of the cyst and that of an adjacent tendon sheath or joint. It is possible, however, that the cyst may originate from a minute portion of synovial membrane being protruded and strangulated so that it becomes disconnected from that to which it originally belonged; it may then degenerate and give rise to colloid material, which accumulates and forms a cyst. Ledderhose and others regard ganglia as entirely new formations in the peri-articular tissues, resulting from colloid degeneration of the fibrous tissue of the capsular ligament, occurring at first in numerous small areas which later fuse to form a single cavity. Ganglia are

probably, therefore, of the nature of degeneration cysts arising in the capsule of joints.

*Treatment.*—If a ganglion causes deformity or disability, it can be got rid of by an aseptic modification of the old-fashioned seton. The overlying skin and cyst wall are transfixed by a stout curved needle carrying a double thread of thick silk-worm gut, the ends of which are cut short, and a dressing applied. A week later the threads are removed and the minute punctures sealed with collodion. The action of the threads is to excite an aseptic granulation of the cyst wall, which results in its obliteration. When this fails, recourse should be had to excision. Puncture with a tenotomy knife and scraping the interior, and the injection of irritants, are alternative, but less satisfactory, methods of treatment.

The so-called "compound palmar ganglion" has been shown to be a tuberculous disease of the tendon sheaths, and will be described with the diseases of tendon sheaths.

# CHAPTER XII.

## INJURIES.

Contusions—Wounds: *Varieties*—Wounds by Firearms and Explosives: *Varieties*—Burns and Scalds—Injuries produced by Electricity.

### Contusions.

A contusion or bruise is a laceration of the subcutaneous soft tissues, without solution of continuity of the skin. When the integument gives way at the same time, a *contused wound* results. Bruising occurs when force is applied to a part by means of a blunt object, whether as a direct blow, a crush, or a grazing form of violence. If the force acts at right angles to the part, it tends to produce localised lesions which extend deeply; while if it acts obliquely, it gives rise to lesions which are more diffuse, but comparatively superficial. It is well to remember that those who suffer from scurvy, or hæmophilia (bleeders), and fat and anæmic females, are liable to be bruised by comparatively trivial injuries.

*Clinical Features.*—The less severe forms of contusion are associated with *ecchymosis*. This is characterised by the occurrence of numerous minute and discrete punctate hæmorrhages scattered through the superficial layers of the skin, which is slightly œdematous. The effused blood is rapidly reabsorbed.

The more severe forms are attended with *extravasation*, the extravasated blood being widely diffused through the cellular tissue of the part, especially where this is loose and lax, as in the region of the orbit, the scrotum and perineum, and on the chest wall. A blue or bluish-black discoloration occurs in patches, varying in size and depth with the degree of force which produced the injury, and in shape with the instrument employed. It is most intense in regions where the skin is naturally thin and pigmented. In

parts where the extravasated blood is only separated from the oxygen of the air by a thin layer of epidermis or by a mucous membrane, it retains its bright arterial colour. These points are often well illustrated in cases of black eye, where the blood effused under the conjunctiva is bright red, while that in the eyelids is almost black. In severe contusions associated with great tension of the skin—for example, over the front of the tibia or around the ankle—blisters often form on the surface and constitute a possible source of septic infection. When deeply situated, the blood tends to spread along the lines of least resistance, partly under the influence of gravity, passing under fasciæ, between muscles, along the sheaths of vessels, or in connective-tissue spaces, so that it may only reach the surface after some time, and at a considerable distance from the seat of injury. This fact is sometimes of importance in diagnosis, as, for example, in certain fractures of the base of the skull, where discoloration appears under the conjunctiva or behind the mastoid process a few days after the accident.

Blood extravasated deeply in the tissues gives rise to a firm, resistant, doughy swelling, in which there may be elicited on deep palpation a peculiar sensation, not unlike the crepitus of fracture.

The majority of contusions tend to spontaneous cure, during the progress of which characteristic alterations in the colour of the effused blood take place as a result of changes in the blood pigment. In from twenty-four to forty-eight hours the margins of the blue area become of a violet hue, and as time goes on the discoloured area increases in size, and becomes successively green, yellow, and lemon-coloured at its margins, the central part being the last to change. The rate at which this play of colours proceeds is so variable, and depends on so many circumstances, that no time-limits can be laid down. During the disintegration of the effused blood the adjacent lymphatic glands may become enlarged, and on dissection may be found to be pigmented.

Sometimes the blood collects in a space—for example, under the aponeurosis of the occipito-frontalis, in the tunica vaginalis, or in a large connective-tissue space—and constitutes a *hæmatoma*. The encapsulation of such an effusion, by proliferation of the connective tissue around it, may give rise to a *hæmorrhagic cyst* (p. 212).

It frequently happens that, from the tearing of lymphatic vessels, serous fluid is extravasated, and a *lymphatic* or *serous cyst* may form (p. 212).

In all contusions accompanied by extravasation there is marked swelling of the area involved, as well as pain and tenderness. The temperature may rise to 101° F., or, in the large extravasations which occur in bleeders, even higher—a form of aseptic fever (Fig. 12). The degree of shock is variable, but sudden syncope frequently results from severe bruises of the testicle, abdomen, or head, and occasionally marked nervous depression follows these injuries.

Contusion of muscles or nerves may produce partial atrophy and paresis, as is often seen after injuries in the region of the shoulder.

In alcoholic or other debilitated patients, suppuration is liable to ensue in bruised parts, infection taking place from cocci circulating in the blood, or through the overlying skin.

*Treatment.*—If the patient is seen immediately after the accident, elevation of the part, and firm pressure applied by means of a thick pad of cotton wool and an elastic bandage, are useful in preventing effusion of blood. Ice-bags and evaporating lotions are to be used with caution, as they are liable to lower the vitality of the damaged tissues and lead to gangrene.

When extravasation has taken place before the patient is seen, massage is the most speedy and efficacious means of dispersing the effused blood. The part should be rubbed centripetally several times a day, for from fifteen to thirty minutes, unless the presence of blebs or abrasions of the skin prevent this being done. When this is the case the use of antiseptic dressings is called for to prevent infection and to promote healing, after which massage is employed.

When the tension caused by the extravasated blood threatens the vitality of the skin, incisions may be made, but only if absolute asepsis can be assured. The blood from a hæmatoma may be withdrawn by an exploring needle, and the puncture sealed with collodion. Septic complications must be met on general principles.

## Wounds.

A wound is a solution in the continuity of the skin or mucous membrane and the underlying tissues.

Three varieties of wounds are described : incised, punctured, and contused and lacerated.

**Incised Wounds.**—The best examples of incised wounds are those made deliberately by the surgeon in the course of an operation. Wounds accidentally inflicted by cutting instruments

and suicidal cut-throat wounds are also of the incised variety. It should be borne in mind in connection with medico-legal inquiries, that wounds of soft parts which closely overlie a bone, such as the skull, the tibia, or the patella, although inflicted by a blunt instrument, may have all the appearances of incised wounds.

*Clinical Features.*—One of the most characteristic features of an incised wound is its tendency to gape. This is evident in long skin wounds, and especially when the cut runs across the part, or when it extends deeply enough to divide muscular fibres at right angles to their long axis. The gaping of a wound, further, is more marked when the underlying tissues are in a state of tension—as, for example, in inflamed parts. Incised wounds in the palm of the hand, the sole of the foot, or the scalp, however, have little tendency to gape, because of the close attachment of the skin to the underlying fascia.

Incised wounds, especially in inflamed tissues, tend to bleed profusely; and when a vessel is only partially divided and is therefore unable to contract, it continues to bleed longer than when completely cut across.

The *special risks* of incised wounds are: (1) division of large blood-vessels, leading to profuse hæmorrhage; (2) division of nerve-trunks, resulting in motor and sensory disturbances; and (3) division of tendons or muscles, interfering with motion. Septic infection is, of course, a risk common to all varieties of wounds.

*Treatment.*—If hæmorrhage is still going on it must be arrested by pressure, torsion, or ligature, as completely as possible, as the accumulation of blood in a wound interferes with union. If necessary, the wound should be purified, by washing with saline solution or with peroxide of hydrogen, after which the edges are approximated by sutures. The raw surfaces must be brought into accurate apposition, care being taken that no inversion of the cutaneous surface takes place. In extensive and deep wounds it may be advisable to unite the deeper structures by a separate series of *buried* sutures of catgut or other absorbable material. For the approximation of the skin edges, stitches of horse-hair, fishing-gut, or fine silk are the most appropriate. These *stitches of coaptation* may be interrupted (Fig. 53) or continuous (Figs. 51, 52). In small superficial wounds on exposed parts, stitch marks may be avoided by approximating the edges with strips of gauze fixed in position by collodion, or by subcutaneous sutures of fine catgut. Where the skin is loose, as, for example, in the neck, on the limbs, or in

the scrotum, the use of Michel's suture clips is advantageous in so far as these bring the deep surfaces of the skin into accurate apposition, are introduced with comparatively little pain, and leave a very slight mark.

When there is any difficulty in bringing the edges of the wound into apposition, a few interrupted *relaxation stitches* may be introduced wide of the margins to take the strain off the coaptation stitches (Fig. 53). Stout silk, fishing-gut, or silver wire may be employed for this purpose. When the tension is extreme Lister's button suture (Fig. 51) may be employed. Relaxation stitches should be removed in four or five days, and stitches of coaptation in from ten to fourteen days. Stitches on the face and neck should be removed in two or three days, so as to leave less mark.

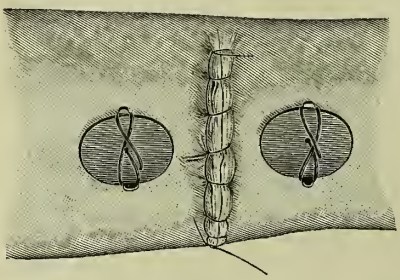


FIG. 51.—Continuous Suture, uniting Edges of Wound. Button Sutures of Relaxation.

*Drainage.*—In wounds in which no cavity has been left, and

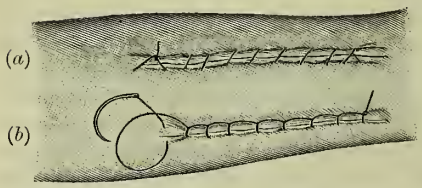



FIG. 52.—Continuous Sutures: (*a*) Glover's Stitch; (*b*) Blanket or Button-hole Stitch.



FIG. 53.—Interrupted Sutures. Two wide Sutures of Relaxation.

in which there is no reason to suspect septic infection, drainage is unnecessary. When the deeper parts of an extensive wound cannot be brought into accurate apposition, and especially when there is any prospect of oozing of blood or serum into the space left—as in amputation stumps or in such wounds as are left after excision of the breast—drainage is indicated. It is a wise precaution also to insert drainage tubes into wounds in very fat

patients where there is the slightest reason to suspect the presence of septic organisms. Glass or rubber tubes are the best drains, but where it is desirable to leave little mark a few strands of horse-hair or of sterilised worsted, or a small roll of protective or rubber tissue, forms a satisfactory substitute. Gauze is not a satisfactory draining material. Except when sepsis occurs, all drains may be removed in from one to four days.

The wound should be protected by means of suitable dressings, and the part kept at rest by bandages, splints, or other appropriate means.

**Punctured Wounds.**—Punctured wounds are produced by narrow, pointed instruments, and the sharper and smoother the instrument the more does the resulting injury resemble an incised wound; while from more rounded and rougher instruments the edges of the wound are always more or less contused or lacerated. The depth of punctured wounds greatly exceeds their width, and the damage to subcutaneous parts is usually greater than that to the skin. When the instrument transfixes a part, the edges of the wound of entrance may be inverted, and those of the exit wound everted. If the instrument is a rough one, these conditions may be reversed by its sudden withdrawal.

Punctured wounds neither gape nor bleed much. Even when a large vessel is implicated, the bleeding usually takes place into the tissues rather than externally.

The risks incident to this class of wounds are: (1) The extreme difficulty of rendering them aseptic on account of the uncertainty as to their depth, and the way in which the surface wound closes on the withdrawal of the instrument. This risk is greater when a dense fascia has been perforated, as it immediately closes and renders purification or the removal of foreign bodies difficult. (2) Different forms of aneurysm may result from the puncture of large vessels. (3) Perforation of a joint, or of a serous cavity, such as the abdomen, thorax, or skull, materially adds to the danger.

*Treatment.*—The first indication is to sterilise carefully the whole extent of the wound, and to remove any foreign body which may have been left in it. That this may be done satisfactorily it is usually necessary to enlarge the wound, freely dividing injured fasciæ. Blood-clots are cleared out, bruised tissues pared away, and the whole wound-surface purified. Any blood-vessel which is punctured should be cut across and tied, and divided muscles, tendons, or nerves must be sutured. After hæmorrhage has been arrested the wound is drained. If septic complications ensue they are met by incisions and drainage.

**Contused and Lacerated Wounds.**—These may be considered together, as they so occur in practice. They are produced by crushing, biting, or tearing forms of violence—such as result from machinery accidents, firearms, or the bites of animals. In addition to the irregular wound of the integument there is always more or less bruising of the parts beneath and around, and the lesions are usually much wider in area than at first sight appears.

Wounds of this variety usually gape considerably, especially when there is much laceration of the skin. It is not uncommon to have considerable portions of skin, muscle, or tendon completely torn away.

Hæmorrhage is seldom a prominent feature, as the crushing or tearing of the vessel walls leads to the obliteration of the lumen.

The special risks of these wounds are: (1) Sloughing of the bruised tissues, especially when attempts to sterilise the wound have not been completely successful. (2) Reactionary hæmorrhage after the initial shock has passed off. (3) Secondary hæmorrhage as a result of septic processes ensuing in the wound. (4) Loss of muscle or tendon, interfering with motion. (5) Cicatricial contraction. (6) Gangrene, which may follow occlusion of main vessels, or virulent infective processes. (7) It is not uncommon to have particles of carbon embedded in the tissues after lacerated wounds, leaving unsightly, pigmented scars. This is often seen in coal-miners, and in those injured by firearms, and is to be prevented by carefully removing all gross dirt from the edges of the wound.

*Treatment.*—In severe wounds of this class implicating the extremities, the most important question that arises is whether or not the limb can be saved. In examining the limb, attention should first be directed to the state of the main blood-vessels, in order to determine if the vascular supply of the part beyond the lesion is sufficient to maintain its vitality. Amputation is usually called for if there is complete absence of pulsation in the distal arteries and if the parts are cold. If at the same time important nerve-trunks are lacerated, the probability of gangrene ensuing is increased. If, in addition, there is extensive destruction of large muscular masses or of important tendons, or comminution of the bones, amputation is usually imperative. Stripping of large areas of skin is not in itself a reason for removing a limb, as much can be done to replace skin by grafting, but when it is associated with other lesions it favours the major operation. In considering these points it must be borne in mind that the damage to the deeper tissues is always more

extensive than appears at first sight, and that in many cases it is only possible to estimate the real extent of the injury by administering an anæsthetic and exploring the wound. In doubtful cases the possibility of rendering the parts aseptic will often decide the question for or against amputation. If thorough purification is accomplished, the success which attends conservative measures is often remarkable. It is permissible to run an amount of risk to save an upper extremity which would be quite unjustifiable in the case of a lower limb. The age and occupation of the patient must also be taken into account.

When it is decided to make the attempt to save the limb the wound must be carefully and thoroughly purified. If necessary it may be enlarged, so that all bruised tissue in which gross dirt has become engrained may be clipped away with scissors. The raw surface should be thoroughly cleansed with sterilised salt solution or peroxide of hydrogen. All rough scrubbing with strong antiseptics is to be avoided, as being only calculated to depress the vitality of the tissues without increasing the probability of rendering the wound aseptic. The wound should be left unstitched, freely drained or packed with gauze, and immobilised by suitable splints. When granulations have formed, skin-grafting may hasten the healing of the wound.

## Wounds by Firearms and Explosives.

The present consideration of gun-shot wounds refers chiefly to such injuries as are met with in civil practice. The subject will be dealt with under the following heads:—Pistol-shot wounds, wounds by sporting-guns, wounds by rifle-bullets, and shell wounds.

Whatever the nature of the weapon, the wound is of the *contused and lacerated* variety. Its severity depends on the size, shape, and velocity of the missile, the range at which the weapon is discharged, and the part of the body struck.

Shock is a prominent feature in most cases of gun-shot wound, but its degree, as well as the time of its onset, varies with the extent and seat of the injury, and with the mental state of the patient when shot. At the moment of injury the patient experiences a sensation which is variously described as being like the lash of a whip, a blow with a stick, or an electric shock. There is not much pain at first, but later it may become severe, and is usually associated with intense thirst, especially when much blood has been lost.

Recent experience has shown that even in active warfare the

great majority of gun-shot wounds heal by first intention if treated on antiseptic principles from the first, by the intelligent application of the field dressing with which each soldier is provided. Nussbaum puts it tersely—"The fate of the wounded rests in the hands of the one who applies the first dressing."

Considerable difference of opinion exists as to the advisability of removing embedded bullets, some authorities holding that unless causing definite symptoms they should be left alone, while others advocate their extraction to obviate possible later complications and to relieve the mind of the patient. It is needless to say that, in localising bullets as a preliminary to operation, invaluable aid is obtained by the use of the Röntgen rays. By the aid of stereoscopic skiagraphy, or Mackenzie-Davidson's "cross-thread localiser," or by taking two or more skiagrams in different planes, the position of a bullet can be determined with great accuracy. This procedure has entirely superseded the employment of special probes and other instruments for this purpose. Nélaton's probe, which is furnished with a knob of unglazed porcelain at its end, was formerly much used in searching for bullets, the lead of the bullet leaving a mark on the porcelain. It is, however, of no special value in detecting the presence of modern bullets, as the hard mantle leaves no mark on the china. Various forms of electric bullet detectors or "telephone probes" have been employed. The probe is made of some insulating material, and carries in its interior two wires connected with a battery. When the ends of these wires come in contact with a metallic substance, such as a bullet, and the circuit is thus completed, the needle of a galvanometer is moved or a small bell is rung.

**Pistol-shot Wounds.**—Wounds inflicted by pistols, revolvers, and small air-guns are of frequent occurrence in civil practice, the weapon being discharged usually by accident, but frequently with suicidal, and sometimes with homicidal intent.

With all calibres and at all ranges except on actual contact, the wound of entrance is smaller than the bullet. If the weapon is discharged within a foot of the body, the skin surrounding the wound is usually stained with smoke and burned, and the hair singed. At ranges varying from six inches to thirty feet, grains of powder may be found embedded in the skin or lying loose on the surface, the greater the range the wider being the area of spread. When black powder is used the embedded grains usually leave a permanent bluish-black tattooing of the skin. When the weapon is placed in contact with the skin, the subcutaneous tissues are lacerated over an area of two or three

inches around the opening made by the bullet, and smoke and powder staining and scorching are more marked than at longer ranges.

When the bullet perforates, the exit wound is usually larger and more extensively lacerated than the wound of entrance. Its margins are as a rule everted, and it shows no marks of flame, smoke, or powder.

Pistol wounds only produce dangerous effects when fired at close range, and when the cavities of the skull, the thorax, or the abdomen are implicated. These injuries will be described with regional surgery.

Pistol-shot wounds of *joints* and *soft parts* are seldom of serious import apart from the risk of septic infection.

*Treatment.*—The treatment of recent wounds of the soft parts consists in purifying the bullet tracks with a view to preventing septic complications. An attempt may have to be made to remove the bullet, the exact position of which should, if possible, be determined by the use of the Röntgen rays. If the patient is not seen until the wound has healed, and if the bullet is deeply lodged and causes no inconvenience, it may be left alone. Probes should be avoided in searching for bullets in soft parts overlying joints or serous cavities; the wounds should be enlarged, if necessary, to admit the finger for purposes of exploration.

**Wounds by Sporting-guns.**—The weapons most commonly used in this country for sporting purposes are the 12- or 16-bore gun, and, less frequently, the smaller 20-bore. The cartridges are usually loaded with amberite or other smokeless powder, and carry a charge of from two to three hundred small pellets (No. 5 or No. 6 shot), weighing from 300 to 450 grains.

The charge of small shot leaves the muzzle of the gun as a cylinder, gradually becoming spherical as the pellets scatter, till, at about twenty feet from the muzzle, the dispersion is complete, each pellet taking its own course.

When the object struck is within one and a half to two feet of the muzzle of the gun, the charge makes a single, sharply cut wound, somewhat oval in outline, having much the appearance of a wound produced by a single bullet. The wound of exit is much larger and more ragged, and the tissues through which the charge has passed are torn and lacerated by the scattering of the pellets. If a bone is struck it is shattered and the soft parts around it are destroyed by the deflection of the shot, which tear up the tissues through which they pass. Portions of bone may be driven out through the exit wound and cause great laceration of its edges.

Pellets striking the shafts of long bones may become flattened or distorted, and when cancellated bone is struck they remain embedded in it.

When the charge impinges over one of the large cavities of the body the shot may scatter widely through the contained viscera, and there is often no exit wound. In the thorax, for example, if a rib is struck, the charge, and possibly fragments of bone, will penetrate the pleura, and be dispersed throughout the lung; in the head, the skull may be shattered and the brain torn up; and in the abdomen, the hollow viscera may be perforated in many places and the solid organs lacerated.

On covered parts, the clothing, by deflecting the shot, influences the size and shape of the wound; the entrance wound is increased in size and more ragged, and portions of the clothes may be driven into it.

By the discharge of small shot at a distance of from two to four feet from the muzzle, the central wound is slightly ragged; and beyond four feet, the pellets begin to disperse so that there are separate punctures round the central opening. As the distance increases these outlying punctures make a wider and wider pattern, till at ten feet they cover an area of about five inches. The central opening is at its largest about six or seven feet from the muzzle; beyond this it gradually gets smaller, till at ten or fifteen feet it is scarcely recognisable, and at twenty feet it has completely disappeared, each individual pellet making its own puncture.

When the shot have diverged so as to strike singly they seldom do much harm, but when a large number of pellets lodge close to one another the skin is very apt to slough. Fatal damage may be done to the brain or to the aorta, or the eye may be seriously injured by a single pellet.

Small shot fired at longer ranges—up to about a hundred and fifty feet—usually go through the skin, but seldom pierce the fascia, and lie embedded in the subcutaneous tissue, from which they can readily be extracted.

The wad of the cartridge behaves very erratically: so long as it remains flat it goes off with the rest of the charge, and is often buried in the wound; but if it curls up or turns on its side it is usually deflected and flies clear of the shot. It may make a separate wound.

A charge of small shot is much more destructive to blood-vessels, tendons, and ligaments than a single bullet, which in many cases pushes such structures aside without actually dividing them. In the abdomen and chest, also, the damage done by

a full charge of shot is much more extensive than that inflicted by a single ball, the deflection of the pellets leading to a greater number of perforations of the intestines and more widespread laceration of solid viscera.

When a charge of small shot fired at close range strikes the surface of the body obliquely, considerable portions of soft tissues may be carried away, leaving a large ragged wound, with torn margins, in which stray pellets are often embedded.

**Wounds by Rifle-bullets.**—The vast majority of wounds inflicted by rifle-bullets are met with in the field during active warfare, and fall to be treated by military surgeons. They occasionally occur accidentally, however, during range practice, and may then come under the notice of the civil surgeon.

It is only necessary here to consider the effects of modern small-bore bullets—that is, anything less than 0·350 inch in diameter, as no others are now used by civilised armies.

The Lee-Enfield rifle, which is the present arm of the British army, fires a bullet 1·25 inch in length, 0·311 inch in diameter, and weighing about 215 grains. It is composed of a core of lead hardened with antimony, incased in an envelope of cupro-nickel alloy, and it leaves the muzzle of the gun with a velocity of 2060 feet per second.

The Mauser bullet is 1·21 inch long, 0·275 inch in diameter, and weighs about 175 grains. It has a steel sheath, and its muzzle velocity is 2380 feet per second.

These may be taken as the types of modern military projectiles. The trajectory is practically flat up to 500 yards. In destructive effect there is not much difference between them; they will kill up to a distance of two miles. The hard covering is employed to enable the bullet to take the grooves in the rifle, and to prevent it stripping as it passes through the barrel. It also increases the penetrating power of the missile, but diminishes its "stopping" power, unless a vital part or a long bone is struck. By removing the covering from the point of the bullet, as is done in the Dum-Dum bullet, or by splitting the end, the bullet is made to expand or "mushroom," when it strikes the body, and its stopping power is thereby greatly increased, the resulting wound being much more severe. These "soft-nosed" expanding bullets are to be distinguished from "explosive" bullets, which contain substances which detonate on impact. High-velocity conical bullets are less likely to lodge in the body than the old spherical balls. Spent shot may merely cause bruising of the surface, or they may pass through the skin and lodge in the subcutaneous tissue.

A blank cartridge fired at close range may cause a severe wound, and, if black powder is used, leave a permanent bluish-black pigmentation of the skin.

**Effects of Small-bore Bullets on different Tissues.**—When the projectile passes through the *soft parts without striking a bone*, it makes a small round aperture at the point of entrance, and an exit wound which is slightly if at all larger—indeed, they can scarcely be distinguished from one another. So minute are these wounds that they may readily be overlooked, especially as they rarely bleed externally. The wounds are smaller than the bullet which produces them, and their size does not appear to bear any constant relation to the range at which the weapon is fired. As a rule no clothing or other foreign body is carried into the wound, and healing by first intention is almost invariable. The patient often feels as if he had been sharply struck with a hammer, and shock is comparatively slight, even when the abdomen is perforated. In short-range wounds there is usually considerable hæmorrhage into the subcutaneous tissues.

**Shafts of Long Bones.**—The effect of a small-bore bullet on the *diaphysis* of a long bone is influenced chiefly by the range at which the bullet was fired, that is, by its velocity at the moment of impact. In nearly all cases a comminuted fracture results. Lieutenant-Colonel Hickson[1] divides these fractures into three varieties: (1) the *short-range type* (up to 200 yards), in which the bullet passes through the medullary cavity at a high velocity, producing an entrance wound which is small, circular, and equal in diameter to the bullet, and an exit wound which is larger and irregular with ragged edges. The bone is so highly comminuted that several inches of its length may be pulverised, and long fissures pass into the shaft beyond. Fragments of bone may be carried out through the skin, producing secondary apertures of exit, from which fragments of muscle or tendon may protrude. Such wounds almost always become infected.

In (2)—the *medium-range type* (300 to 800 yards)—the exit wound is still larger than the entrance, but the soft parts are not lacerated to the same extent. The bone is highly comminuted, but not forced out of the tissues, neither is it broken into so many or such small fragments. Short fissures radiate in a stellate form to the periphery of the bone.

In (3)—the *long-range type* (over 900 yards)—the entrance and exit wounds tend to approximate in size. The soft parts are not injured to any marked extent. There is less tendency to complete separation of fragments, and these are few in number, although they may be large in size. The bullet often lodges in the bone or soft tissues. Suppuration does not often occur in this variety.

**Cancellous Ends of Long Bones and Joints.**—In some cases the bullet perforates the cancellous tissue of the epiphysis of a long bone without causing comminution or involving the adjacent joint. As a rule, however, it passes through the joint in its course, giving rise to an effusion of blood into the cavity, but without causing fissuring or comminution of the articular surfaces.

In rare cases, and particularly in the knee-joint, the bullet traverses the synovial cavity without impinging on the osseous elements. The

[1] Official Report of the Surgical Cases noted in the South African War, 1890-1902.

great majority of bullet-wounds implicating joints remain aseptic, and the function of the joint is not impaired.

"The presence of fluid in an articulation is not pathognomonic of joint injury, as it not infrequently occurs in connection with injuries of the shaft not implicating the epiphysis."

**Blood-vessels.**—Wounds of large blood-vessels are comparatively common. They are clean-cut sections or perforations when the vessels are directly struck, and oval perforations when hit tangentially. The small-bore bullet, however, is capable of causing such damage to the walls of an artery by the merest graze, that, although no actual opening is made into it at the time, sloughing of the part of the vessel so injured takes place later, and hæmorrhage or a traumatic aneurysm is the result. If the vessel is a large one and placed superficially or in one of the cavities of the body, hæmorrhage is speedily fatal; but when the blood cannot escape externally, and collects in the tissues, it may cause sufficient tension to arrest the bleeding, and a traumatic aneurysm results (Surgeon-General Stevenson). When an artery and its accompanying vein are injured an aneurysmal varix develops.

Bullet-wounds of *nerves* are described on page 335.

**Head Injuries.**—Surgeon-General Stevenson[1] divides bullet-wounds of the head into (1) *scalp wounds with contusion of the skull*, and (2) *fractures*. The former are due to the impact of a bullet travelling at a low velocity and impinging very obliquely on the head. Even although the bone is not visibly damaged there may be marked symptoms of concussion, and in some cases small hæmorrhages and laceration of the brain result and give rise to symptoms of irritation or of compression. In these injuries the prognosis is always favourable.

Gun-shot fractures are divided into (*a*) *gutter fractures*, in which a trench is ploughed through the outer table and diploë, while the inner table is comminuted, small fragments sometimes being driven through the dura.

(*b*) *Penetrating fractures*, in which there is only one aperture in the calvaria, and the bullet, not having sufficient impetus to carry it through the brain, lodges in it. The opening is large and irregular, and fragments of considerable size may be depressed or even driven into the brain, causing serious laceration of its substance.

(*c*) *Perforating fractures*, which vary in character with the range at which the weapon is discharged. At close range very serious damage is inflicted, considerable portions of the skull and brain are sometimes blown away, and death is usually immediate. At medium and long ranges, if the bullet strikes perpendicularly to the surface the apertures of entrance and exit are usually circular and clean-cut; if it strikes obliquely, the entrance wound is oval, with short thread-like fissures radiating from it, and the exit wound is larger and more irregular and portions of bone may be driven outwards. In either case the inner table is more widely shattered at the aperture of entrance, and the outer table at that of exit.

In all varieties of fracture there are marked symptoms of brain injury, usually referable to the areas traversed by the bullet.

Cerebral abscess and hernia cerebri are the most common complications of gun-shot fractures.

Even in the absence of brain symptoms, all cases in which there is

[1] Official Report of the Surgical Cases noted in the South African War, 1890-1902.

evidence of actual fracture of the skull require operation to enable the wounds to be purified and to permit of depressed fragments of bone being elevated or loose fragments removed. Foreign bodies lodged in the brain should be removed if easy of access, but prolonged searching for them is not permissible. The experience of the South African War showed that the results of these operations are on the whole eminently satisfactory.

**Spine.**—From the records of the Boer War it would appear that in a considerable number of cases in which the vertebræ were injured by small-bore bullets, even although the bony walls of the spinal canal had not been fractured or depressed, and no extra-dural or intra-medullary hæmorrhage had occurred, the spinal cord in the vicinity was degenerated into a "custard-like material" incapable of any conducting power (Makins). According to Stevenson, this "must have been due to the vibratory concussion communicated to it by the passage of the bullet at a high rate of velocity." The importance of this observation lies in the fact that in such cases no benefit can follow operative interference.

The cord may be partially or completely cut across by a bullet; and extra-dural and intra-medullary hæmorrhage may accompany injuries to the bones. These lesions, as well as gun-shot fractures of the vertebræ, present the same clinical features and call for the same treatment as similar injuries produced in other ways (vol. ii. chap. vi.).

**Chest.**—*Non-penetrating* wounds are often accompanied by fractures of ribs, sternum, or shoulder girdle, and as the projectile is frequently lodged in the tissues, sepsis is liable to ensue. External hæmorrhage is uncommon, but, even although the lung is not directly injured, hæmoptysis is often present.

In *penetrating* wounds it is often impossible to distinguish between the apertures of entrance and exit, and, even when the missile has passed through the lung, there is very seldom any external hæmorrhage. In most cases these wounds run an aseptic course, and they are seldom complicated by pleurisy or pneumonia. The symptoms most frequently present are: a variable and often remarkably slight degree of shock, some cyanosis and dyspnœa, slight and transient pain, and increased rapidity of pulse-rate. Hæmoptysis is seldom a prominent symptom. Hæmothorax is the most serious complication; it is frequently accompanied by a slight degree of pneumothorax, and is usually attended with a rise of temperature even when aseptic. These lesions and their complications are treated on the same lines as when due to other forms of injury (vol. ii. chap. xx.). The removal of bullets and other foreign bodies lodged in the cavity of the thorax is only to be attempted when they are causing symptoms and can be accurately localised by the X-rays.

Wounds of the *heart* or pericardium are usually rapidly fatal, but recovery has taken place in cases in which there was every reason to believe that the heart had been perforated.

**Wounds of the Abdomen.**—Recent experience has demonstrated that small-bore bullets usually produce comparatively slight disturbance even when they perforate hollow as well as solid viscera; and that for such injuries the results of surgical interference are extremely disappointing. In the South African War a very large percentage of perforating abdominal wounds recovered without operation—a result which is attributed to the fact that modern bullets make very minute punctures in the intestine, which immediately close. As the peristalsis

is arrested by the shock of the injury, nothing escapes, especially if the patient is not subjected to movement for some hours, and if, as is usually the case in active warfare, he has been fasting for some time before being wounded. The punctures in the gut have therefore time to become occluded by peritoneal adhesions before the intestinal contents pass along the injured segment.

The passage of a small-bore bullet through a *solid viscus*—such as the liver, spleen, pancreas, or kidney—produces comparatively little laceration; hence there is little or no bleeding, and few symptoms of any moment ensue.

Operations performed on the field are contra-indicated in abdominal injuries, as they are calculated to prevent the formation of the adhesions which naturally close the perforations, or to break down such as have occurred.

**Shell Wounds and Wounds produced by Explosions.**—It is convenient to consider together the effects of the bursting of shells fired from heavy ordnance in warfare, and those resulting in the course of blasting operations from the discharge of dynamite or other explosives, or from the bursting of steam boilers or pipes, the breaking of machinery, and similar accidents occurring in civil practice.

Two types of shell are used by artillery: the *common shell*, which consists of a hollow metal cylinder containing a bursting charge of powder, discharged either by a time-fuse or by impact; and *Shrapnel shell*, the cavity of which contains several hundred large round bullets, which are dispersed by the bursting of the shell, which is timed to take place from 50 to 100 yards in front of the enemy. The destructive effect is produced by the fragments into which the shell bursts, together with, in the case of Shrapnel, the shower of bullets thus set free.

Wounds inflicted by shell fragments and Shrapnel bullets tend to be extensive in area, but they do not penetrate deeply, and they show great contusion, laceration, and destruction of the tissues implicated. On account of their comparatively low velocity the missiles frequently lodge in the tissues. Shell wounds are attended with a considerable degree of shock. On account of the wide area of contusion which surrounds the actual wound produced by shell fragments, amputation, when called for, should be performed some distance above the torn tissues, and the prognosis in all cases should be guarded, as there is considerable risk of sloughing of the flaps. Unlike the wounds produced by small-bore bullets, those resulting from shell fragments comparatively seldom run an aseptic course.

Wounds produced by dynamite explosions, the bursting of boilers, and the breaking of machinery have the same general characters as shell wounds. Fragments of stone, coal, or

metal may lodge in the tissues, and if infected cause septic complications.

All such injuries are to be treated on the general principles governing contused and lacerated wounds.

## Burns and Scalds.

A burn results from the application of dry heat to the tissues of the body; and a scald from the application of moist heat. This distinction, however, has no clinical importance.

Burns are most frequently produced by flames—as, for example, when a child's clothes catch fire; by gas, paraffin, or gunpowder explosions; or by contact with molten metal or hot solids. Electricity and exposure to Röntgen rays also produce similar lesions. Scalding is usually due to contact with boiling fluids, or to the escape of steam in boiler explosions. In young and debilitated subjects hot poultices may produce injuries of this kind.

It is an interesting fact that in old people with enfeebled circulation mere exposure before a strong fire may produce severe degrees of burning, the clothes covering the part being uninjured. This may occur about the feet, legs, or knees, the patient usually having fallen asleep before the fire while intoxicated.

The damage done to the tissues by strong caustics, such as fuming nitric acid, sulphuric acid, caustic potash, nitrate of silver, or arsenical paste, presents pathological and clinical features almost identical with those resulting from heat.

*Pathology of Burns.*—Much discussion has taken place regarding the explanation of the rapidly fatal issue in extensive superficial burns. On post-mortem examination the lesions found in these cases are: (1) general hyperæmia of all the organs of the abdominal, thoracic, and cerebro-spinal cavities; (2) marked leucocytosis, with destruction of red corpuscles, setting free hæmoglobin which lodges in the epithelial cells of the tubules of the kidneys; (3) minute thrombi and extravasations throughout the tissues of the body; (4) degeneration of the ganglion cells of the solar plexus; (5) general œdema and degeneration of all the lymphoid tissue throughout the body; (6) cloudy swelling of the liver and kidneys, and softening and enlargement of the spleen. Bardeen suggests that these morbid phenomena correspond so closely to those met with where the presence of a toxin is known to produce them, that in all

probability death is similarly due to the action of some poison, the source and nature of which are as yet unknown.

**Clinical Features.—Local Phenomena.**—The most generally accepted classification of burns is that of Dupuytren, which is based upon the depth of the lesion. Six degrees are thus recognised: (1) hyperæmia or erythema; (2) vesication; (3) partial destruction of the true skin; (4) total destruction of the true skin; (5) charring of muscles; (6) charring of bones.

It must be observed, however, that burns met with at the bedside always illustrate more than one of these degrees. The deeper forms are always associated with those less deep, and the clinical picture is made up of the combined characters of all. A burn is classified in terms of its most severe portion. It is also to be remarked that the extent and severity of a burn usually prove to be greater than at first sight appears.

*Burns of the first degree* are associated with erythema of the skin, due to hyperæmia of its blood-vessels, and result from scorching by flame, from contact with solids or fluids below 212° F., or from exposure to the sun's rays. They are characterised clinically by acute pain, redness, transitory swelling from oozing of serum into the tissues, and subsequent desquamation of the surface layers of the epidermis.

*Burns of Second Degree—Vesication of the Skin.*—These are characterised by the occurrence of vesicles or blisters which are scattered over the hyperæmic area, and contain a clear yellowish or brownish fluid. On removing the raised epidermis the congested and highly sensitive papillæ of the skin are exposed. Unna has found that pyogenic bacteria are invariably present in these blisters. Burns of the second degree leave no permanent scar but frequently a persistent discoloration. In rare instances the burned area becomes the seat of keloid.

*Burns of Third Degree—Partial Destruction of the True Skin.*—The epidermis and papillæ are destroyed in patches, leaving hard, dry, and insensitive sloughs of a yellow or black colour. The pain in these burns is intense, but passes off during the first or second day, to return again, however, when, about the end of a week, the sloughs separate and expose the nerve filaments of the underlying skin. Granulations spring up to fill the gap, and are rapidly covered by epithelium, derived partly from the margins and partly from the remains of skin glands which have not been completely destroyed. These latter appear on the surface of the granulations as small bluish islets which gradually increase in size, become of a greyish-white colour, and ultimately blend with one

another and with the edges. The resulting cicatrix may be slightly depressed, but otherwise exhibits little tendency to contraction and deformity.

*Burns of Fourth Degree—Total Destruction of the True Skin.*—These follow the prolonged application of any form of intense heat. Large, black, dry eschars are formed, surrounded by a zone of intense congestion (Fig. 54). Pain is less severe, and is experienced in the parts which have been burned to a less degree. Septic infection is very liable to result and to lead to



FIG. 54.—Burn of Fourth Degree, with large black Slough in centre, in course of treatment by Picric Acid. The patient was burned by falling into the fire while intoxicated. Recovery.

wide destruction of the surrounding skin. The amount of granulation tissue necessary to fill the gap is therefore great; and as the epithelial covering can only be derived from the margins—the skin glands being completely destroyed—the healing process is slow. The resulting scars are irregular, deep and puckered, and show a great tendency to contract. Keloid frequently develops in such cicatrices. When situated in the region of the face, neck, or flexures of joints, much deformity and impairment of function may result (Figs. 55, 56).

In *burns of the fifth degree* the lesion extends through the subcutaneous tissue and involves the muscles; while in those of the *sixth degree* it passes still more deeply and implicates the

bones. These burns are comparatively limited in area, as they are usually produced by prolonged contact with hot metal or caustics. Burns of the fifth and sixth degrees are sometimes met with in epileptics who fall into the fire during a fit. Large blood-vessels, nerve-trunks, joints, or serous cavities may be implicated.

**General Phenomena.**—It is customary to divide the clinical history of a severe burn into three periods; but it is to be observed that the features characteristic of the periods have been greatly modified since burns have been treated on the same lines as other wounds.

The *first period* lasts for from thirty-six to forty-eight hours, during which time the patient remains in a more or less profound state of shock, and there is a remarkable absence of pain. When shock is absent or little marked, however, the amount of suffering may be very great. When the injury proves fatal during this period, death is due to shock, probably aggravated by the absorption of poisonous substances produced in the burned tissues. In fatal cases there is often evidence of cerebral congestion and œdema.

The *second period* begins when the shock passes off, and lasts till the sloughs separate. The outstanding features of this period are fever, the temperature rising to 102°, 103°, or 104° F.; and congestive or inflammatory conditions of internal organs, giving rise to such clinical complications as bronchitis, broncho-pneumonia, or pleurisy—especially in burns of the thorax; or meningitis and cerebritis, when the neck or head is the seat of the burn. Intestinal catarrh associated with diarrhœa is not uncommon; and ulceration of the duodenum leading to perforation has been met with in a few rare cases. These phenomena are much more prominent when septic infection takes place and the discharge is profuse. It seems more than probable that they are all to be attributed more or less directly to septic absorption, especially in view of the fact that they have become much less frequent and less severe since burns have been treated on antiseptic principles. Albuminuria is a fairly constant symptom in severe burns, and is probably due to congestion of the kidneys. In burns implicating the face, neck, mouth, or pharynx, œdema of the glottis is a dangerous complication, entailing as it does the risk of suffocation.

The *third period* begins when the sloughs separate, usually between the seventh and fourteenth days, and lasts till the wound heals, its duration depending upon the size, depth, and asepticity of the raw area. The chief causes of death during

this period are septic absorption in any of its forms; waxy disease of the liver, kidneys, or intestine; less commonly erysipelas, tetanus, or other diseases due to infection by specific organisms. It is stated that duodenal ulcers have sometimes perforated and caused death during the third period.

The *prognosis* in burns depends on (1) the superficial extent, and, to a much less degree, the depth of the injury. When more than one-third of the entire surface of the body is involved, even in a mild degree, death usually follows. (2) The situation of the burn is important. Burns over the serous cavities—abdomen, thorax, or skull—are, other things being equal, much more dangerous than burns of the limbs. The risk of œdema glottidis in burns about the neck and mouth has been already referred to. (3) Children are more liable to succumb to shock during the early periods, but withstand prolonged suppuration better than adults. (4) When the patient survives the shock the presence or absence of sepsis is the all-important factor in prognosis.

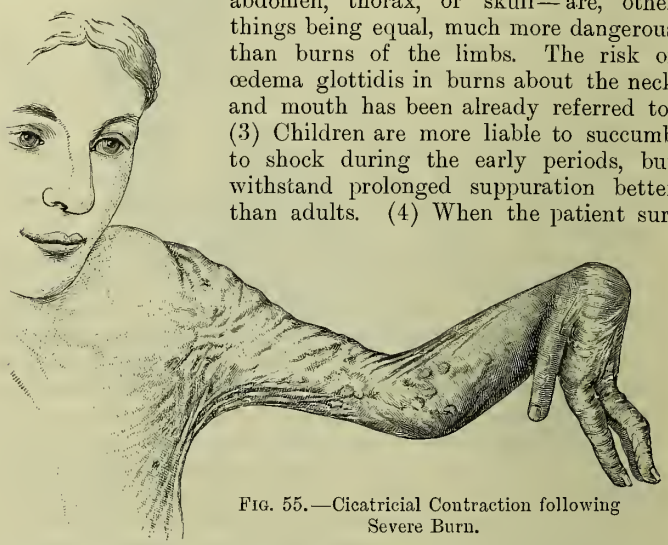


Fig. 55.—Cicatricial Contraction following Severe Burn.

**Treatment.**—The *general treatment* consists in combating the shock (p. 244). When pain is severe, morphin must be injected.

*Local Treatment.*—This must be carried out on the most rigid antiseptic lines, a general anæsthetic being administered, if necessary, to ensure the purification being carried out thoroughly. After carefully removing the clothes, the whole of the burned area is gently, but thoroughly, washed with a mild antiseptic lotion, such as warm boracic or weak lysol, followed by sterilised saline solution. As pyogenic bacteria are invariably found in

the blisters of burns, these must be opened and the raised epithelium removed.

The dressings subsequently applied should meet the following indications: the relief of pain; the prevention of sepsis; and the promotion of cicatrisation.

The application which most satisfactorily fulfils these requirements is *picric acid*, which is applied to the surface as a watery solution—made up of picric acid, 1½ drams; absolute alcohol, 3 ounces; distilled water, 40 ounces.

Pads of lint or gauze are lightly wrung out of the solution and applied over the whole of the reddened area. These are covered with antiseptic wool, *without* any waterproof covering, and retained in position by a many-tailed bandage. The injured part should be kept at rest by a splint or other suitable appliance. The dressing should be changed once or twice a week, any portion of the original dressing which remains perfectly dry being left undisturbed. The value of a general anæsthetic in dressing extensive burns, especially in children, can scarcely be overestimated.

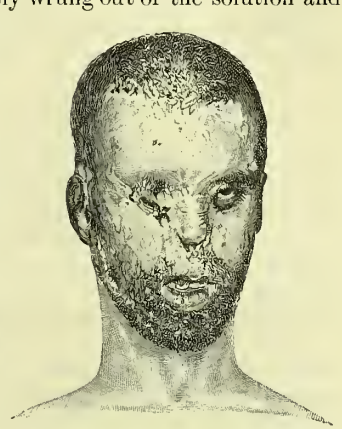


FIG. 56.—Cicatricial Contraction after Burn resulting from Explosion in Coal-pit, and causing Deformity of Eyelids, Nose, and Mouth.

Picric acid yields its best results in the more superficial burns, but is useful as a primary dressing in all. As soon as the sloughs separate and a granulating surface forms, the ordinary treatment for a healing sore is instituted (p. 83). Any slough under which pus has collected should be cut away with scissors to permit of free drainage.

An alternative method of treating extensive burns is by immersing the part, or even the whole body when the trunk is affected, in a bath of boracic lotion kept at the body temperature, the lotion being frequently renewed.

When a burn is already septic when first seen by the surgeon, it is to be treated on the same principles as govern the treatment of other infected wounds.

All moist or greasy applications, such as Carron oil, carbolic oil and ointments, and all substances like collodion and dry powders, which retain discharges, entirely fail to meet the

indications for the rational treatment of burns, and should be abandoned.

Skin-grafting is of great value in hastening healing after extensive burns, and in preventing cicatricial contraction. The *deformities* which are so liable to develop from contraction of the cicatrices resulting from burns are treated on the general principles governing plastic operations. In the region of the face (Fig. 56), neck, and flexures of joints (Fig. 55), where they are most marked, the contracted bands may be divided and the parts stretched, the raw surface left being covered by Thiersch grafts or by flaps of skin raised from adjacent surfaces and glided or twisted into position.

### Injuries produced by Electricity.

Lesions of the nature of burns result from the action of electricity on the tissues of the body. They differ sufficiently from ordinary burns to merit separate description, and may be considered under the headings of (1) injuries produced by exposure to the Röntgen rays, (2) electrical burns, and (3) lightning-stroke.

**Injuries produced by Exposure to the Röntgen Rays.**—It would appear that these injuries only follow exposure to electric discharges emanating from a Crooke's tube; that the patient experiences no sensation of electric shock or of heat; and that prolonged or repeated exposure is usually necessary to their production. Owing to the systematic use of shields, the shorter exposures, and the improved technique generally, these injuries are now comparatively rare.

Two distinct varieties of burn are recognised—an erythematous form, resembling a superficial burn; and an ulcerative and sloughing form, corresponding to a burn of the third or fourth degree.

The *erythematous* form is usually met with on the back of the hands and fingers of those who work with the Röntgen apparatus, but occasionally occurs in patients who have been subjected to the rays for diagnostic or therapeutic purposes. The first symptom is the appearance of a red patch on the skin, attended with itching, but devoid of pain. This seldom appears sooner than two or three weeks after the exposure. The skin becomes dry, tends to crack, and finally desquamates. The hairs are lost and the nails become brittle. The sense of touch is sometimes impaired. The condition is very persistent, and usually lasts for several months. It disappears spontaneously,

but is liable to recur if the parts are again exposed to the influence of the rays. Sometimes the hair is lost without any other lesion; it may begin to grow again in a few weeks, or the loss may be permanent.

The *ulcerative* form is met with in patients subjected to the rays for a prolonged period, and usually begins within a week of the exposure, although in some cases the first signs have been delayed for two or three weeks. The onset is marked by redness of the skin and slight pain. In a few days a blister containing sero-purulent fluid rises, and after bursting leaves a raw surface which is extremely painful. A slough slowly forms and gradually increases in size, spreading through the deep fascia and exposing the muscle. The prominent features of this form are the extreme slowness with which the sloughs separate,—the process sometimes occupying several months,—and the severity of the pain, which usually calls for the administration of opiates. The raw surface left after the separation of the slough is very slow to heal, and during the process fresh patches of necrosis may appear.

The treatment is carried out on the same lines as in other forms of burns. When it is practicable, recovery may be hastened by excising the slough and applying Thiersch grafts over the raw area.

**Electrical burns** usually occur in those who are engaged in industrial undertakings where powerful electrical currents are employed.

The lesions—which vary from a slight superficial scorching to complete charring of parts—are most evident at the points of entrance and exit of the current, the intervening tissues apparently escaping injury.

The more superficial degrees of electrical burns differ from those produced by heat in being almost painless, and in healing very slowly, although as a rule they remain dry and aseptic.

The more severe forms are attended with a considerable degree of shock, which is not only more profound, but also lasts much longer than the shock in an ordinary burn of corresponding severity. The parts at the point of entrance of the current are charred to a greater or less depth. The eschar is at first dry and crisp, and is surrounded by a zone of pallor. For the first thirty-six to forty-eight hours there is comparatively little suffering, but at the end of that time the parts become exceedingly painful. In a majority of cases, in spite of careful purification, a slow form of moist gangrene sets in, and the slough spreads both in area and in depth, until the muscles and often the large

blood-vessels and nerves are exposed. A line of demarcation eventually forms, but the sloughs are exceedingly slow to separate, taking from three to five times as long as in an ordinary burn, and during the process of separation there is considerable risk of secondary hæmorrhage taking place from erosion of large vessels.

*Treatment.*—Electrical burns are treated on the same lines as ordinary burns, by thorough purification and the application of dry antiseptic dressings, with a view to avoiding the onset of moist gangrene. After this has occurred and granulations have formed, skin-grafting is of great value in hastening healing.

**Lightning-stroke.**—In a large proportion of cases lightning-stroke proves instantly fatal. In non-fatal cases the patient suffers from a profound degree of shock, and there may or may not be any external evidence of injury. In the mildest cases red spots or wheals—closely resembling those of urticaria—may appear on the body, but they usually fade again in the course of twenty-four hours. Sometimes large patches of skin are scorched or stained, the discoloured area showing a markedly arborescent appearance. In other cases the injured skin becomes dry and glazed, resembling parchment. Appearances are occasionally met with corresponding to those of a superficial burn produced by heat. The chief difference from ordinary burns is the extreme slowness with which healing takes place. Localised paralysis of groups of muscles, or even of a whole limb, may follow any degree of lightning-stroke. Treatment is mainly directed towards combating the shock, the surface lesions being treated on the same lines as ordinary burns.

# CHAPTER XIII.

## CONSTITUTIONAL EFFECTS OF INJURIES.

Syncope — Shock — Collapse — Delirium in Surgical Patients: *Delirium in general; Delirium Tremens; Traumatic Delirium*— Fat Embolism. Traumatic Asphyxia.

### Syncope, Shock, and Collapse.

Syncope, shock, and collapse are clinical conditions which, although depending on different causes, bear a superficial resemblance to one another. Syncope is essentially due to a sudden cerebral anæmia; shock to a reflex paralysis of the vaso-motor centre in the medulla; while the cause of collapse is the abstraction of fluids from the tissues and the blood.

**Syncope or Fainting.**—Syncope is the result of a suddenly produced anæmia of the brain, from temporary weakening or arrest of the heart's action. In surgical practice this condition is usually observed in nervous persons who have been subjected to pain, as in the reduction of a dislocation or the incision of a whitlow; or in those who have rapidly lost a considerable quantity of blood. It may also follow the sudden withdrawal of fluid from a large cavity, as in tapping an abdomen or withdrawing serous fluid or pus from the pleural cavity. Fainting sometimes occurs also during the administration of chloroform, especially if there is a tendency to sickness and the patient is not completely under. During an operation the onset of syncope is often recognised by the cessation of oozing from the divided vessels in the wound, before the general symptoms become manifest.

*Clinical Features.*—When a person is about to faint he feels giddy, has surging sounds in the ears, and haziness of vision; he yawns, becomes pale and sick, and a free flow of saliva takes place into the mouth. The pupils dilate; the pulse becomes small and almost imperceptible; the respirations shallow and

hurried; consciousness gradually fades away, and he falls in a heap on the floor.

Sometimes vomiting ensues before the patient completely loses consciousness, and the muscular exertion entailed may ward off the actual faint. This is frequently seen in threatened syncopal attacks during chloroform administration.

Recovery begins in a few seconds, the patient sighing or gasping, or, it may be, vomiting; the strength of the pulse gradually increases, and consciousness slowly returns. In some cases, however, syncope is fatal.

*Treatment.*—The head should at once be lowered—in imitation of nature's method—to encourage the flow of blood to the brain, the patient, if necessary, being held up by the heels. All tight clothing, especially round the neck or chest, must be loosened. The heart may be stimulated reflexly by dashing cold water over the face or chest, or by rubbing the face vigorously with a rough towel. The application of volatile substances, such as ammonia or smelling-salts, to the nose; the administration by the mouth of sal-volatile, whisky or brandy, and the intramuscular injection of ether, are the most speedily efficacious remedies. In severe cases the application of hot cloths over the heart, or of the faradic current over the line of the phrenic nerve, just above the clavicle, may be called for.

**Shock** is a profound lowering of the vital activity following almost immediately on the receipt of some injury in a previously healthy person.

Various factors are at work in the production of shock. It may be due to intense mental emotion, with or without an associated injury. Even slight injuries to unimportant tissues may be followed by severe shock, but, other things being equal, the more severe the injury and the more vital the organ affected the greater is the shock. Loss of blood also increases the severity of shock. Damage to parts richly supplied with nerves—especially those derived from the sympathetic system, such as the abdominal or thoracic viscera—is usually attended with profound degrees of shock. Pain is certainly a factor, although in many cases the severity of the shock bears no direct relation to the intensity of the pain. Persons with a highly strung nervous system suffer more from shock than do those of a more phlegmatic temperament. Shock is always a risk to be reckoned with in operations on young children, for while many suffer little from shock even after severe operations, others, with much less cause, succumb to it.

When the injured person's mind is absorbed with other

matters than his own condition,—as, for example, during the heat of a battle or in the excitement of a railway accident or a conflagration,—even severe injuries may be unattended by pain or shock at the time, although when the period of excitement is over the severity of the shock is all the greater. The same thing is observed in persons injured while under the influence of alcohol.

The explanation of shock usually accepted, largely on the authority of Crile and Mummery, is that the symptoms result from exhaustion of the vaso-motor centre in the medulla, whereby the vascular tone, particularly that of the arteries, is lessened and the blood pressure falls. Most of the blood is said to leave the arteries and to collect in the large venous trunks, especially those of the abdomen, and there is thus produced an anæmia of the brain and of the superficial parts of the body. At the same time the right side of the heart becomes overloaded, and impeded in its action. The view which best accords with the clinical phenomena, however, is that put forward by J. D. Malcolm, according to whom the disturbance of the vaso-motor centre results, not in dilatation, but in contraction of the arteries. At first the superficial vessels are constricted, and, if the exciting cause is kept up, this condition spreads back to the larger vessels, so that the blood is driven out into the tissues and back into the abdominal veins.

*Clinical Features.*—The patient is in a state of great prostration. He is roused from his condition of indifference with difficulty, but answers questions intelligently, if only in a whisper. The face is pale, beads of sweat stand out on the brow, the features are drawn, the eyes sunken, and the cheeks hollow. The lips and ears are pallid; the skin of the body of a greyish colour, cold, and clammy. The pulse is rapid, fluttering, and often all but imperceptible at the wrist; the respiration is irregular, shallow, and sighing; and the temperature may fall to 96° F. or even lower. The mouth is parched, and the patient complains of thirst. There is little sensibility to pain, and for purposes of operation very little anæsthetic is required to render the patient unconscious.

Except in very severe cases, shock tends towards recovery within a few hours, the *reaction*, as it is called, being often ushered in by vomiting. The colour improves; the pulse becomes full and bounding; the respiration deeper and more regular; the temperature rises to 100° F. or higher; and the patient begins to take notice of his surroundings.

In certain cases the symptoms of shock so closely resemble

those resulting from septic absorption that it is difficult, if not impossible, to distinguish between them, and there can be little doubt that many deaths have been attributed to shock which were really due to acute septicæmia. The conditions formerly known as "delayed shock" and "prostration with excitement" are now generally recognised to be due to septic absorption.

*Question of Operating during Shock.*—Most authorities agree that operations should only be undertaken during profound shock when they are imperatively demanded for the arrest of hæmorrhage, the prevention of septic infection of serous cavities, or for the relief of pain which is producing or intensifying the condition.

*Prevention of Operation Shock.*—About half an hour before a prolonged and severe operation, the patient should receive a nutrient enema of brandy and peptonised meat juice, and a hypodermic injection of $\frac{1}{20}$ grain of strychnine. The operating-room must be warm—not less than 70° F.—and the patient should be wrapped in cotton wool and blankets, and surrounded by hot-bottles. All lotions used must be warm (100° F.); and the operation should be completed as speedily and as bloodlessly as possible. With a view to preventing the passage of exciting afferent impulses Crile advocates "blocking" of the nerves, by the injection of a 1 per cent. solution of cocaine or eucaine into their substance on the proximal side of the field of operation.

*Treatment.*—A patient suffering from shock should be placed in the recumbent position with the foot of the bed raised to facilitate the return circulation in the large veins, and so to increase the flow of blood to the brain. His bed should be placed near a large fire, and the patient himself surrounded by cotton wool and blankets and hot-bottles. If the patient has lost much blood, the limbs should be wrapped in cotton wool and firmly bandaged from below upwards, to conserve as much of the circulating blood as possible in the trunk and head. As soon as he has been put to bed, about a pint of normal saline solution (one dram of sodium chloride to a pint of boiled water) should be injected into the rectum. Ten to fifteen minims of adrenalin chloride (1 in 1000) may with advantage be added to the saline fluid. The injection should be repeated every two hours until the circulation is sufficiently restored. Cardiac stimulants in the form of strychnine ($\frac{1}{60}$ to $\frac{1}{30}$ grain), digitaline ($\frac{1}{100}$ grain), or strophanthine ($\frac{1}{300}$ to $\frac{1}{200}$ grain) may be administered hypodermically if necessary, but care must

be exercised in the use of these drugs. Nutrient enemata containing stimulants may also be given.

The intra-venous or intra-cellular injection of saline solution at a temperature of about 105° F. is most useful where much blood has been lost (p. 265). Two or three pints may be injected into the veins, or smaller quantities under the skin.

The extreme thirst of which the patient so often complains is best met by giving small quantities of warm water by the mouth, or by the injection of saline solution into the rectum. Ice only relieves thirst for a short time, and as it is liable to induce flatulence should be avoided, especially in abdominal cases. Dryness of the tongue may be relieved by swabbing the mouth with a mixture of glycerin and lemon juice.

If severe pain after operation calls for the use of morphin, $\frac{1}{120}$ grain of atropin should be added to avoid the depressing effect of the opiate.

Artificial respiration may be useful in tiding a patient over the critical period of shock.

**Collapse** is a clinical condition which comes on more insidiously than shock, and which does not attain its maximum degree of severity for several hours. It is met with in the course of severe illnesses, especially such as are associated with the loss of large quantities of fluid from the body—for example, by severe diarrhœa, notably in Asiatic cholera; by copious vomiting; or by profuse sweating, as in some cases of heat-stroke. Severe degrees of collapse follow any sudden and profuse loss of blood.

Collapse often follows upon shock—for example, in intestinal perforations, or after abdominal operations complicated by peritonitis, especially if there is vomiting, as in cases of obstruction high up in the intestine. The symptoms of collapse are aggravated if septic absorption is superadded to the loss of fluid.

The *clinical features* of this condition are practically the same as those of shock; and it is treated on the same lines.

## Delirium in Surgical Patients.

Delirium is a temporary disturbance of mind which occurs in the course of certain diseases, and sometimes after injuries. It is to be looked upon as a serious and dangerous complication.

The causes of delirium in surgical patients are numerous, and it is not always easy in a given case to discover the cause. Thus, for example, it may be associated with any of the acute

pyogenic infections; with erysipelas, especially when it affects the head or face; or with chronic septic diseases of the urinary organs. In the various forms of meningitis also, and in some cases of injury to the head, it is common; and it is sometimes met with after severe hæmorrhage, and in cases of poisoning by such drugs as iodoform, cocaine, or alcohol. Delirium may, of course, be an evidence of insanity.

It may assume the form of excitement, of dementia, or of melancholia; and the symptoms are usually worst during the night. Incoherent muttering regarding past incidents or occupations, or about absent friends, is a common manifestation of the condition.

**Delirium Tremens** is seen in persons addicted to alcohol who, as a result of accident or operation, are suddenly compelled to lie in bed for some time. Although oftenest met with in habitual drunkards or chronic tipplers, it is by no means uncommon in moderate drinkers, and has even been seen in children.

*Clinical Features.*—The delirium, which has been aptly described as being of a "busy" character, usually first manifests itself within a few days of the patient being laid up. For two or three days he refuses food, is depressed, suspicious, sleepless and restless, desiring to be allowed out of bed. Then he begins to mutter incoherently, to pull off the bed-clothes, and to attempt to rise. There is general muscular tremor, most marked in the tongue, the lips, and the hands. The patient imagines that he sees all sorts of horrible beings around him, and is sometimes greatly distressed because of rats, mice, beetles, or snakes which he fancies are crawling over him. The pulse is soft, rapid, and compressible; the temperature is only moderately raised (100°-101° F.), and as a rule there is profuse sweating. The digestion is markedly impaired, and there is often vomiting. Patients in this condition are peculiarly insusceptible to pain, and may even walk about with a fractured leg without apparent discomfort.

In most cases the symptoms begin to pass off in three or four days; the patient sleeps, the hallucinations and tremors cease, and he gradually recovers. In other cases the temperature rises, the pulse becomes running, and death results from exhaustion.

The main indication in *treatment* is to secure sleep, and this is done by the administration of bromides, chloral, trional, paraldehyde, or sulphonal. Morphin must be used with great caution. In some cases hyoscin ($\frac{1}{200}$ grain) injected hypodermically is found efficacious when all other methods have failed, but this drug must be used with great discrimination. The patient must be encouraged to take plenty of easily digested

fluid food, supplemented, if necessary, by nutrient enemata and saline injections.

In the early stage a brisk mercurial purge is often of value. Alcohol should be withheld, unless failing of the pulse strongly indicates its use, and then it should be given in the food.

A delirious patient must be constantly watched by a trained attendant or other competent person, lest he get out of bed and do harm to himself or others. Mechanical restraint is often necessary, but must be avoided if possible, as it is apt to increase the excitement and exhaust the patient. On account of the extreme restlessness, there is often great difficulty in carrying out the proper treatment of the primary surgical condition, and considerable modifications in splints and other appliances are often rendered necessary.

A form of delirium, sometimes spoken of as **Traumatic Delirium**, may follow on severe injuries or operations in persons of neurotic temperament, or in those whose nervous system is exhausted by overwork. It is met with apart from alcoholic intemperance. This form of delirium seems to be specially prone to ensue on operations on the face, the thyroid gland, or the genito-urinary organs. The symptoms appear in from two to five days after the operation, and take the form of restlessness, sleeplessness, low incoherent muttering, and picking at the bed-clothes. It is not necessarily attended by fever or by muscular tremors. The patient may show hysterical symptoms. This condition is probably to be regarded as a form of insanity, and the patient may become maniacal or melancholic.

The *treatment* is carried out on the same lines as that of delirium tremens.

**Fat Embolism.** — After various injuries and operations, but especially such as implicate the marrow of long bones — for example, comminuted fractures, osteotomies, resections of joints, or the forcible correction of deformities — fluid fat may enter the circulation in variable quantity. In the vast majority of cases no ill effects follow, but when the quantity is large or when the absorption is long continued certain symptoms ensue, either immediately, or more frequently not for two or three days. These are mostly referable to the lungs and brain.

In the lungs the fat collects in the minute blood-vessels and produces venous congestion and œdema, and sometimes pneumonia. Dyspnœa, with cyanosis, a persistent cough and frothy or blood-stained sputum, a feeble pulse and low temperature, are the chief symptoms.

When the fat lodges in the capillaries of the brain the pulse

becomes small, rapid, and irregular, delirium followed by coma ensues, and the condition is usually rapidly fatal.

Fat is usually to be detected in the urine, even in mild cases.

The *treatment* consists in tiding the patient over the acute stage of his illness, until the fat is eliminated from the blood-vessels.

**Traumatic Asphyxia or Traumatic Cyanosis.**—This term has been applied to a condition which results when the thorax is so forcibly compressed that respiration is mechanically arrested for several minutes. It has occurred from the patient being crushed in a struggling crowd, or under a fall of masonry, and in machinery accidents. When the patient is released, the face and the neck as far as the level of the clavicles present an intense discoloration, varying from deep purple to blue-black. The affected area is very sharply defined, and on close inspection the appearance is found to be due to the presence of countless minute reddish-blue or black spots, with small areas or streaks of normal skin between them. The punctate nature of the discoloration is best recognised towards the periphery of the affected area—at the junction of the brow with the hairy scalp, and where the dark patch meets the normal skin of the chest (Beach and Cobb). Pressure over the skin does not cause the colour to disappear as in ordinary cyanosis. It has been shown by Wright, of Boston, that the discoloration is due to stasis from mechanical over-distension of the veins and capillaries, and that there is no actual extravasation into the tissues outside the blood-vessels. The sharply defined distribution of the discoloration is attributed to the absence of functionating valves in the veins of the head and neck, so that when the increased intra-thoracic pressure is transmitted to these veins they become engorged. Under the conjunctivæ there are gross extravasations of bright red blood.

The discoloration begins to fade within a few hours, and after the second or third day it rapidly disappears without showing any of the chromatic changes which characterise the disappearance of a bruise. The sub-conjunctival ecchymosis, however, persists for several weeks and disappears like other gross extravasations. Apart from combating the shock, or dealing with concomitant injuries, no treatment is called for.

# CHAPTER XIV.

## THE BLOOD-VESSELS.

Anatomy—Injuries of Arteries: *Varieties*—Injuries of Veins: *Air Embolism*—Repair of Blood-vessels and natural arrest of hæmorrhage—Hæmorrhage: *Varieties; Prevention; Arrest*—Constitutional effects of hæmorrhage—Hæmophilia—Diseases of Blood-vessels: Thrombosis; Embolism—Arteritis: *Varieties;* Atheroma—Thrombo-phlebitis—Phlebitis: *Varieties*—Varix—Angiomata—Nævus: *Varieties; Electrolysis*—Cirsoid Aneurysm—Aneurysm: *Varieties; Methods of Treatment*—Aneurysms of Individual Arteries.

**Surgical Anatomy.**—An *artery* has three coats: an internal coat—the *tunica intima*—made up of a single layer of endothelial cells lining the lumen; outside of this a layer of delicate connective tissue; and still further out a dense tissue composed of longitudinally arranged elastic fibres—the internal elastic lamina. The tunica intima is easily ruptured. The middle coat, or *tunica media*, consists of non-striped muscular fibres arranged for the most part concentrically round the vessel. In this coat also there is a considerable proportion of elastic tissue, especially in the larger vessels. The thickness of the vessel wall depends chiefly on the development of the muscular coat. The external coat, or *tunica adventitia*, is composed of fibrous tissue, containing, especially in vessels of medium calibre, some yellow elastic fibres in its deeper layers.

In most parts of the body the arteries lie in a sheath of connective tissue, from which fine fibrous processes pass to the tunica adventitia. The connection, however, is not a close one, and the artery when divided transversely is capable of retracting for a considerable distance within its sheath. In some of the larger arteries the sheath assumes the form of a definite membrane.

The arteries are nourished by small vessels—the *vasa vasorum*—which ramify chiefly in the outer coat. They are also well supplied with nerves which regulate the size of the lumen by inducing contraction or relaxation of the muscular coat.

The *veins* are constructed on the same general plan as the arteries, the individual coats, however, being thinner. The inner coat is less easily ruptured, and the middle coat contains a smaller proportion of muscular tissue. In one important point veins differ structurally from arteries—namely, in being provided with valves which prevent reflux of

the blood. These valves are composed of semilunar folds of the tunica intima strengthened by an addition of connective tissue. Each valve usually consists of two semilunar flaps attached to opposite sides of the vessel wall, each flap having a small sinus on its cardiac side. The distension of these sinuses with blood closes the valve and prevents regurgitation. Valves are absent from the superior and inferior venæ cavæ, the portal vein and its tributaries, the hepatic, renal, uterine, and spermatic veins, and from the veins in the lower part of the rectum. They are ill-developed or absent also in the iliac and common femoral veins—a fact which has an important bearing on the production of varix in the veins of the lower extremity.

The wall of *capillaries* consists of a single layer of endothelial cells.

## Injuries of Arteries.

The following description of the injuries of arteries refers entirely to the larger, named trunks. The injuries of smaller, unnamed vessels are included in the consideration of contusions and wounds.

The injuries to which the larger arteries are liable are: contusion, subcutaneous rupture, laceration with an open wound, and punctured, incised, and gun-shot wounds.

**Contusion.**—An artery may be contused by a blow or crush, or by the oblique impact of a bullet. The bruising of the vessel wall, especially if atheroma is present, may result in the formation of a thrombus which occludes the lumen temporarily or even permanently, and in rare cases may lead to gangrene.

**Subcutaneous Rupture.**—An artery may be ruptured subcutaneously by a blow or crush, or by a displaced fragment of bone. This injury has been produced also during attempts to reduce dislocations, especially those of old standing at the shoulder-joint. It is most liable to occur when the vessels are atheromatous. The rupture may be incomplete or complete.

**Incomplete Rupture.**—In the majority of cases the rupture is incomplete—the inner and middle coats being torn, while the outer coat remains intact. The middle coat contracts and retracts, and the internal, because of its elasticity, curls up in the interior of the vessel, forming a valvular obstruction to the blood-flow. In most cases this results in the formation of a thrombus which occludes the vessel. In some cases the blood pressure gradually distends the injured segment of the vessel wall and produces an aneurysm.

The pulsation in the vessels beyond the seat of rupture is almost always arrested—for a time at least—owing to the occlusion of the vessel, and the limb becomes cold and powerless.

The pulsation seldom returns within five or six weeks of the injury, if indeed it is not permanently arrested. As a rule, however, a good collateral circulation is rapidly established, the vascularity soon being restored. If the pulsation returns within a week of the injury the presumption is that the occlusion was due to pressure from without—for example, by hæmorrhage into the sheath, or the pressure of a fragment of bone.

When an artery has been occluded as a result of contusion and thrombosis, the limb must be placed in the most favourable condition for the restoration of the circulation. The skin is disinfected and the limb wrapped in cotton wool to conserve its heat, and elevated to such an extent as to promote the venous return without at the same time unduly interfering with the inflow of blood. A careful watch must be kept on the state of nutrition of the limb lest gangrene supervene, as this necessitates amputation at or above the level of the obstructed artery.

**Complete Rupture.**—When the rupture is complete, all the coats of the vessel are torn and the blood escapes into the surrounding tissues. If the original injury is attended with much shock, the bleeding may not take place until the period of reaction. Those cases in which the popliteal artery is ruptured in association with fracture of the femur, or the axillary or brachial artery with fracture of the humerus or dislocation of the shoulder, furnish the best examples of complete rupture.

Like incomplete rupture, this lesion is accompanied by loss of pulsation and power, and by coldness of the limb beyond; a tense and excessively painful swelling rapidly appears in the region of the injury, and, where the cellular tissue is loose, may attain a considerable size. The pressure of the effused blood occludes the veins and leads to marked congestion and œdema of the limb beyond. The interference with the circulation, and the damage to the tissues of the limb, may be so great that gangrene ensues.

If no complications supervene the swelling subsides, and recovery may be complete in six or eight weeks. Even in cases of complete rupture expectant treatment has in many cases yielded satisfactory results. If the extravasation is great and the skin threatens to give way, or if the vitality of the limb is seriously endangered, it is advisable to expose the injured vessel, and, after clearing away the clots, to apply a ligature above and below the rupture. If gangrene ensues, amputation must be performed.

**Open Wounds of Arteries—Laceration.**—Laceration of large arteries is a common complication of severe machinery and railway accidents. The violence being usually of a tearing, twisting, or crushing nature, such injuries are seldom associated with much hæmorrhage, as torn or crushed vessels quickly become occluded by contraction and retraction of their coats and by the formation of a clot. A whole limb even may be completely avulsed from the body with comparatively little loss of blood. The great risk in such cases is secondary hæmorrhage resulting from septic infection.

The *treatment* is that applicable to all infected wounds, with, in addition, the ligation of the lacerated vessels.

**Punctured wounds** of blood-vessels may result from stabs, or they may be accidentally inflicted in the course of an operation.

The division of the coats of the vessel being incomplete, the natural hæmostasis which results from curling up of the intima and contraction of the media fails to take place, and bleeding goes on externally and into the surrounding tissues. If the sheath of the vessel is not widely damaged, the gradually increasing tension of the extravasated blood retained within it may ultimately arrest the escape from the vessel. A clot then forms between the lips of the wound in the vessel wall and projects for a short distance into the lumen, without, however, materially interfering with the flow through the vessel. The organisation of this clot may result in the healing of the wound in the vessel wall.

In other cases the blood escapes beyond the sheath and infiltrates the surrounding tissues, and an aneurysm results. Secondary hæmorrhage may occur if the wound becomes septic.

The *treatment* consists in enlarging the external wound sufficiently to enable it to be purified, and to permit of the damaged vessel being ligatured above and below the puncture. In some cases it may be possible to suture the opening in the vessel wall. When circumstances prevent this treatment being carried out, the bleeding may be arrested by making firm pressure over the wound with a pad. This procedure, however, is liable to be followed by the formation of an aneurysm.

**Incised Wounds.**—We here refer only to such incised wounds as partially divide the vessel wall.

Longitudinal incised wounds show little tendency to gape, and are therefore not attended with much bleeding. They usually heal rapidly, but, like punctured wounds, are liable to be followed by the formation of an aneurysm.

When, however, the incision in the vessel wall is oblique or

transverse, the retraction of the muscular coat causes the opening to gape, with the result that there is profuse hæmorrhage, which, even in comparatively small arteries, may prove dangerous. When the associated wound in the soft parts is valvular an aneurysm may develop.

When a large arterial trunk, such as the external iliac, the femoral, the common carotid, the brachial, or the popliteal, has been partially divided, for example, in the course of an operation, the opening should be closed with sutures—*arteriorraphy*. The circulation being controlled by a tourniquet, fine silk or catgut stitches are passed through the adventitia and media after the method of Lembert, a thin, round needle being employed. Part of the sheath of the vessel or of an adjacent fascia should be stitched over the line of suture in the vessel wall. If septic infection be excluded there is little risk of thrombosis or secondary hæmorrhage. In the case of smaller trunks, or when suture is impracticable, the artery should be ligatured above and below the opening, and divided between the ligatures.

**Gun-shot wounds** of blood-vessels are described at page 229.

## Injuries of Veins.

Veins are subject to the same forms of injury as arteries, and the results are in most respects alike in both, such variations as occur being dependent partly on the difference in their anatomical structure, and partly on the conditions of the circulation through them.

**Subcutaneous rupture** of veins occurs under the same conditions as the corresponding injury of arteries, and more particularly in association with fractures and in the reduction of dislocations. The veins most commonly ruptured are the popliteal, the axillary, the femoral, and the subclavian. On account of the smaller amount of elastic and muscular tissue in a vein, the contraction and retraction of its walls is less than in an artery, and so bleeding may continue for a much longer period. On the other hand, owing to the lower blood pressure in a vein the outflow goes on more slowly, and the gradually increasing pressure produced by the extravasated blood is usually sufficient to arrest the hæmorrhage before it has become serious. As an aid in diagnosing the source of the bleeding, it should be remembered that the rupture of a vein does not affect the pulsation in the limb beyond. The risks are practically the same as when an artery is ruptured, and the treatment is carried out on the same lines, but in the case of veins it is

seldom necessary to operate for the purpose of applying a ligature to the injured vessel.

**Wounds** of veins—punctured and incised—frequently occur in the course of surgical operations; for example, in the removal of tumours or diseased glands from the neck, the axilla, or the groin. They are also met with as a result of accidental stabs and of suicidal or homicidal injuries. The hæmorrhage from a large vein so damaged is usually profuse, but owing to the comparatively low blood pressure is more readily controlled by external pressure than that from an artery. When a vein is merely punctured, the bleeding may be arrested either by applying pressure with a pad of gauze, or by lateral ligature —that is, picking up the margins of the rent in the wall and securing them with a ligature without occluding the lumen. It is sometimes possible to suture the opening in the wall of the vein. This does not result in obliteration of the lumen, nor does a thrombus necessarily form.

When an *artery and vein are simultaneously wounded* the features peculiar to each are present in greater or less degree. In the limbs the risk of gangrene is increased, and this is especially liable to ensue if the wound becomes infected. Punctured and gun-shot wounds implicating both artery and vein, as well as those due to modern small-bore bullets, are liable to be followed by the development of arterio-venous aneurysm.

**Entrance of Air into Veins—Air Embolism.**—This serious, though fortunately rare, accident is apt to occur in the course of operations in the region of the thorax, neck, or axilla, if a large vein is opened and fails to collapse on account of the rigidity of its walls, its incorporation in a dense fascia, or from traction being made upon it. If a vein is thus held open the negative pressure in the vessel during inspiration sucks air into the right side of the heart. This is accompanied by a peculiar hissing or gurgling sound, and with the next expiration some frothy blood leaves the wound in the vessel wall. The patient instantly becomes pale, the pupils dilate, respiration becomes laboured, and, although the heart may continue to beat forcibly, the peripheral pulse is weak, and may even be imperceptible. On auscultating the heart a churning sound may be heard. Death may result in a few minutes; or the heart may slowly regain its power and recovery take place.

These symptoms have been attributed (1) to the collection of air in the right side of the heart, so that the right ventricle has no blood on which to contract, and the pulmonary circulation is therefore stopped; (2) to the passage of air into the pulmonary

vessels interfering with the circulation in the lungs and preventing the entrance of fresh blood into the left side of the heart; and (3) to the passage of air emboli to the cerebral blood-vessels.

*Prevention.*—In all operations in the "dangerous area"—as the region of the root of the neck is called in this connection—great care must be taken not to notch or cut across any vein before it has been secured by forceps, and to apply ligatures securely and at once. Deep wounds in this region should be kept filled with an aseptic fluid, such as normal salt solution. Immediately a cut is recognised in a vein, a finger should be placed over the vein on the cardiac side of the wound, and kept there until the vessel is secured with forceps.

*Treatment.*—Little can be done after the air has actually entered the vein beyond endeavouring to keep up the heart's action by hypodermic injections of ether or strychnine, alcoholic enemata, and the application of mustard or hot cloths over the chest. The head at the same time should be lowered to prevent syncope. Attempts to withdraw the air by suction, and the employment of artificial respiration, have proved futile, and are, by some, considered dangerous.

## Repair of Blood-Vessels, and the Natural Arrest of Hæmorrhage.

These processes are so intimately related to one another that it is advisable to consider them together.

(*a*) When the wall of an artery is *partially* torn, or punctured, it may be repaired by the organisation of the clot which forms in the gap, and its subsequent conversion into scar tissue. This cicatrix in the vessel wall, however, is liable subsequently to be stretched by the blood pressure and to become the starting-point of an aneurysm.

(*b*) When an artery is *completely* divided the circular fibres of the muscular coat contract, and so the lumen of the cut ends is diminished. At the same time each segment of the vessel retracts within its sheath, in virtue of the recoil of the elastic elements in its walls. The tunica intima curls up in the interior of the vessel, and the tunica adventitia collapses over the cut ends. The blood which escapes from the injured vessel fills the interstices of the tissues, and, coagulating, forms a clot which temporarily arrests the bleeding. That part of the clot which lies between the divided ends of the vessel and in the cellular tissue outside, is known as the *external clot*, while the portion

which projects into the lumen of the vessel is known as the *internal clot.* The internal clot usually extends into the vessel as far as the nearest collateral branch. These processes constitute what is known as the "temporary arrest of hæmorrhage," which, it will be observed, is effected by the contraction and retraction of the divided artery and the formation of a blood-clot. The "permanent arrest" takes place by the transformation of this clot into scar tissue. The internal clot plays the most important part in the process: it becomes invaded by leucocytes and proliferating endothelial and connective-tissue cells, and new blood-vessels permeate the mass forming granulation tissue. This is ultimately replaced by cicatricial fibrous tissue, which permanently occludes the end of the vessel. Concurrently and by the same process the external clot is converted into scar tissue.

In course of time the collateral branches of the vessel above and below the level of section become enlarged and their intercommunication becomes more free, so that even when large trunks have been divided the vascular supply of the parts beyond may be completely restored. This is known as the development of the collateral circulation.

*Repair of Veins.*—The process of repair in veins is the same as that in arteries, but the thrombosed area may again become canalised and the circulation through the vessel be re-established.

*Conditions which influence the Natural Arrest of Hæmorrhage.*—It has already been mentioned that laceration of a blood-vessel promotes the natural arrest of hæmorrhage, the twisting of the coats favouring the formation of clots. The occurrence of syncope or of profound shock also helps to stop bleeding by reducing the force of the heart's action.

On the other hand, there are various conditions which retard the natural arrest. When, for example, a vessel is only partially divided, the contraction and retraction of the muscular coat, instead of diminishing the calibre of the artery, causes the opening to gape. By completing the division of the vessel under these circumstances the bleeding can often be arrested. In certain situations also the arteries are so intimately connected with their sheaths that when cut across they are unable to retract and contract—for example, in the scalp, in the penis, and in bones—and copious bleeding may take place from comparatively small vessels. This inability of the vessels to contract and retract occurs also in inflamed and œdematous parts and in scar tissue. Arteries divided in the substance of a muscle also sometimes bleed unduly. Any increase in the force of the heart's

action, such as may result from exertion, excitement, or over-stimulation, also interferes with the natural arrest of hæmorrhage.

Lastly, in hæmophilia the deficient coagulability of the blood seriously interferes with the natural arrest of bleeding, even in small vessels.

(*c*) *Ligation of a Vessel in its Continuity.*—When a ligature is applied to an artery it should be pulled sufficiently tight to occlude the lumen without causing rupture of any of its coats. It often happens, however, that the compression causes rupture of the inner and middle coats, so that only the adventitia remains in the grasp of the ligature. While this weakens the wall of the vessel, it has the advantage of hastening coagulation, by bringing the blood into contact with damaged tissue. Whether the inner and middle coats are ruptured or not, blood coagulates both above and below the ligature, the proximal clot being longer and broader than that on the distal side. In small arteries these clots extend as far as the nearest collateral branch, but in the larger trunks their length is variable. The permanent occlusion of those portions of the vessel occupied by clot is brought about by the formation of granulation tissue, and its replacement by cicatricial tissue, so that the occluded segment of the vessel is represented merely by a fibrous cord. In this process the coagulum only plays a passive *rôle* by forming a scaffolding on which the granulations are built up. The ligature which surrounds the vessel, and the elements of the clot, are ultimately absorbed.

(*d*) In a vessel *ligatured at its cut end*—as, for example, in an amputation stump—the reparative process is the same as when it is ligatured in its continuity. The ligature usually tears the internal and middle coats, and so pulls the adventitial coat together. The ligature and the small portion of vessel beyond it are subsequently absorbed.

## Hæmorrhage.

Various terms are employed in relation to hæmorrhage according to its seat, its origin, the time at which it occurs, and other circumstances.

The term *external hæmorrhage* is employed when the blood escapes directly to the surface ; when the bleeding takes place into the tissues or into a cavity it is spoken of as *internal*. The blood may infiltrate the connective tissue of the skin or of deeper parts, constituting an *extravasation* of blood ; or it may collect in a definite space or cavity and form a *hæmatoma*.

The coughing up of blood from the lungs is known as *hæmoptysis*; vomiting of blood from the stomach as *hæmatemesis*; the passage of black-coloured stools due to the presence of blood altered by digestion as *melæna*; and the passage of bloody urine as *hæmaturia*.

Hæmorrhage is known as arterial, venous, or capillary, according to the nature of the vessel from which it takes place.

In *arterial* hæmorrhage the blood is bright red in colour, and escapes from the cardiac end of the divided vessel in forcible jets synchronously with the systole of the heart. In very vascular parts—for example, the face—both ends of a divided artery bleed freely. The blood flowing from an artery may be dark in colour if the patient's respiration is impeded. The flow is sometimes continuous and not in jets when the heart's action is weak and the blood tension low, or when the bleeding takes place into a deep wound and not directly on to the free surface.

*Venous* bleeding is not pulsatile, but occurs in a continuous stream, which, although both ends often bleed, is more copious from the distal end of the vessel. The blood is dark red under ordinary conditions, but may be purplish, or even black, if the patient is becoming asphyxiated. When one of the large veins in the neck is wounded, the effects of respiration produce a rise and fall in the stream which may resemble arterial pulsation. Bleeding from the cardiac end of a varicose vein may be very copious.

In *capillary* hæmorrhage, red blood escapes from numerous points on the surface of the wound in a slow, steady ooze. This form of bleeding is often serious in those who are the subjects of hæmophylia.

In relation to the time at which it occurs, hæmorrhage is spoken of as primary, reactionary, and secondary.

**Primary** hæmorrhage is that which immediately follows a wound of a blood-vessel.

It is convenient to consider separately the treatment of primary hæmorrhage, as it occurs (1) in an accidentally inflicted wound, and (2) in the course of a surgical operation.

**Surgical Arrest of Accidental Hæmorrhage.**—The most efficient means of temporarily controlling profuse hæmorrhage is by pressure applied with the finger, or with a pad of gauze, directly over the bleeding point. While this is maintained an assistant makes digital pressure, or applies a tourniquet, over the main vessel of the limb on the proximal side of the bleeding point. A useful emergency tourniquet may be improvised by folding a large handkerchief *en cravatte*, with a cork or piece of

wood in the fold to act as a pad. The handkerchief is applied round the limb, with the pad over the main artery, and the ends knotted on the outer aspect of the limb. With a strong piece of wood the handkerchief is wound up like a Spanish windlass, until sufficient pressure is exerted to arrest the bleeding.

It is sometimes found on the removal of this extemporised tourniquet that the bleeding has ceased, coagula having formed in the divided vessels. As, however, such wounds are usually infected, it is seldom advisable to trust to this cessation being permanent, because if sepsis occurs in the wound it is liable later to give rise to secondary hæmorrhage. It is safer to remove from the tissues all clots which have formed and are obscuring the divided vessels, and after purifying the wound, to ensure permanent closure of both ends of these by one or other of the means described on p. 261.

When hæmorrhage is taking place from a number of small vessels its arrest may be effected by elevation of the bleeding part, particularly if it is a limb. By this means the force of the circulation is diminished and the formation of coagula favoured. Similarly in wounds of the hand or forearm, or of the foot or leg, bleeding may be arrested by acutely flexing the limb at the elbow or knee respectively.

If the hæmorrhage is from a partially divided vessel, this should be completely cut across to enable its walls to contract and retract, and to facilitate the application of forceps and ligatures.

After any of these measures active stimulation of the patient should be avoided, and absolute rest ensured.

**Hæmorrhage in Surgical Operations.**—The management of the hæmorrhage which accompanies a surgical operation includes (*a*) preventive measures, and (*b*) the arrest of the bleeding.

**Prevention of Hæmorrhage.**—The most convenient and certain means of preventing hæmorrhage—say in an amputation—is by the use of some form of *tourniquet*, such as the elastic tubing of Esmarch or of Foulis, or an elastic bandage, or the screw tourniquet of Petit. Before applying any of these it is advisable to empty the limb of blood. This is best done after the manner suggested by Lister. The limb is held vertical for three or four minutes; the veins are thus emptied by gravitation and they collapse, and as a physiological result of this the arteries reflexly contract, so that the quantity of blood entering the limb is reduced to a minimum. With the limb still elevated the tourniquet is firmly applied, a part being selected where the vessel can be pressed directly against a

bone, and where there is no risk of exerting injurious pressure on important nerve-trunks. To protect the skin the tourniquet should be applied over a few layers of gauze. The first turns of the tourniquet must be rapidly and tightly applied to arrest completely the arterial flow. Unless this is done the veins only are obstructed and the limb becomes congested. In the inferior extremity the best place to apply a tourniquet is the lower third of the thigh, and in the superior, the middle of the upper arm. This "bloodless method" of operating is subject to the objection that, owing to vaso-motor paralysis of the smaller vessels caused by the pressure of the tourniquet, the bleeding which takes place after its removal is often profuse.

When a tourniquet cannot conveniently be applied, or when its presence interferes with the carrying out of the operation—as, for example, in amputations at the hip or shoulder—the hæmorrhage may be controlled by preliminary ligation of the main artery above the seat of operation, for instance, the external iliac or the subclavian. For such contingencies also a special clamp or forceps, such as that suggested by Lynn Thomas, may be employed. In the case of vessels which it is undesirable to occlude permanently, such as the carotids, the temporary application of a ligature or clamp is sometimes most useful.

Many surgeons rely for the control of hæmorrhage upon *digital compression* of the main vessel supplying the limb. The amount of blood lost immediately may be greater than by the "bloodless method," but the small vessels bleed much less, so that the total loss of blood is probably about equal in the two methods.

In selecting a point at which to apply digital compression, it is essential that the vessel should be lying over and close to a bone which will furnish the necessary resistance. The following are the more important vessels which lend themselves to digital compression, and the directions in which the pressure should be applied. The common carotid is pressed backward and inward against the transverse process (carotid tubercle) of the sixth cervical vertebra; the temporal against the zygoma in front of the ear; and the facial against the lower jaw at the anterior edge of the masseter muscle.

In the upper extremity, the subclavian is pressed against the first rib by making pressure downwards and backwards in the hollow above the clavicle; the axillary and brachial by pressing against the shaft of the humerus.

In the lower extremity, the femoral is controlled by pressing in a direction backward and slightly upward against the brim

of the pelvis, midway between the symphysis pubis and the anterior superior iliac spine.

The abdominal aorta may be compressed against the bodies of the lumbar vertebræ opposite the umbilicus, if the spine is arched well forwards over a pillow or sand-bag. The best method is that suggested by Macewen, in which the patient's spine is arched forwards by allowing the lower extremities and pelvis to hang over the lower end of the table, while the assistant, standing on a stool, applies his closed fist over the abdominal aorta and compresses it against the vertebral column.

**Arrest of Hæmorrhage.** — The actual cautery, douching with very hot water, the local application of styptics, and the internal administration of drugs have a limited field of usefulness in the treatment of surgical hæmorrhage.

*Ligature.*—This is the best means of securing the larger vessels. The divided vessel having been caught with forceps as near to its cut end as possible, a ligature, preferably of some absorbable material such as catgut or kangaroo tendon, is tied round it. Fine silk may be preferred, on account of the greater certainty with which it can be sterilised.

*Torsion.*—This method is seldom employed except for comparatively small vessels, but it is applicable to even the largest arteries. In employing torsion, the end of the vessel is caught with forceps, and the terminal portion twisted round several times. The object is to tear the inner and middle coats of the vessel so that they curl up inside the lumen, while the outer fibrous coat is twisted into a cord which occludes the end of the vessel.

*Forci-pressure.*—Bleeding from the smallest arteries and from arterioles can usually be arrested by firmly squeezing them for a few minutes with serrated or grooved artery forceps, such as those of Spencer Wells, Kocher, or Ochsner. It is usually found that on the removal of the forceps at the end of an operation no further hæmorrhage takes place from these vessels. By the use of specially strong clamps, such as those of Doyen, large trunks may be occluded by pressure.

*Cautery.*—The actual cautery or Paquelin's thermo-cautery is seldom employed to arrest hæmorrhage, but is frequently useful in preventing it, as, for example, in the removal of piles, or in opening the bowel in colostomy. It is used at a dull-red heat, which sears the divided ends of the vessels and so occludes the lumen. A bright-red or a white heat cuts the vessel across without occluding it. The separation of the slough produced by the charring of the tissues is sometimes attended with

secondary bleeding, and subsequent cicatricial contraction may be excessive.

*Hot Water.*—Profuse oozing, such, for example, as may occur from the uterus, or from the large raw surface left after excision of the knee, may sometimes be arrested by douching the part with sterilised water at a temperature of about 110° F, which acts by causing contraction of the muscular fibres of the vessel walls.

*Styptics.*—The local application of styptics is seldom to be recommended. In the treatment of epistaxis or bleeding from the nose, of hæmorrhage from the socket of a tooth, and sometimes from ulcerating or granulating surfaces, however, styptics may be useful. All clots must be removed and the drug applied directly to the bleeding surface. Adrenalin is the most useful drug for this purpose.

**Reactionary** or intermediary hæmorrhage is really a recurrence of primary bleeding. As the name indicates, it occurs during the period of reaction—that is, within the first few hours after an operation or injury. It may be due to the increase in the blood pressure which accompanies reaction displacing clots which have formed in the vessels, or causing vessels to bleed which did not bleed during the operation; to the slipping of a ligature; or to the giving way of a grossly damaged portion of the vessel wall. In the scrotum, the relaxation of the dartos during the first few hours after operation occasionally leads to reactionary hæmorrhage.

When the bleeding is due to a ligature having slipped from a large vessel, the wound must be opened up and the vessel again secured. As a rule, however, reactionary hæmorrhage takes place from small vessels as a result of the displacement of occluding clots, and in many cases the hæmorrhage is found to stop when the bandages and soaked dressings are removed. If not, it is usually sufficient in the first instance to apply firm pressure and in the case of a limb to elevate it. Should the hæmorrhage recur, the wound must be reopened, and ligatures applied to the bleeding vessels. Douching the wound with hot sterilised water (about 110° F.), and plugging it tightly with gauze, are often successful in arresting capillary oozing. The internal administration of morphin sometimes proves useful in preventing the recurrence of hæmorrhage by keeping the patient quiet.

The term **Secondary Hæmorrhage** refers to bleeding which is due to some interference with the natural process by which an injured vessel is repaired. It is also employed to describe the bleeding which may result from erosion of a blood-vessel—

for example, by an abscess burrowing into it, or by necrosis of its walls in a septic wound, as in cellulitis of the neck following scarlet fever, or by the pressure of a drainage tube. As secondary hæmorrhage is almost invariably the result of septic processes, it is much less frequent now than it was in pre-antiseptic days. In whatever way the infective material reaches the vessel—whether from suppuration in the wound, from the material used for ligature, or from the blood-stream—it produces an inflammatory softening and disintegration of the occluding clot or young connective tissue, and of the vessel wall. The bleeding which takes place when the vessel at length gives way may at first be slight and may stop spontaneously. It soon recurs, however, and as the destructive process progresses, the recurrences become more frequent and the flow more abundant, until eventually profuse, and it may be fatal, hæmorrhage results.

The occurrence of slight hæmorrhages from a suppurating wound in the vicinity of a large blood-vessel is strongly suggestive of secondary hæmorrhage, and should always lead to steps being taken to avoid more serious bleeding, or to deal with it when it occurs. A Petit's screw tourniquet should be loosely applied to the limb above the wound, and the nurse should be instructed to tighten it up in the event of bleeding taking place, and to summon the surgeon without delay. In most cases, however, it is safer to anticipate serious bleeding by operative measures.

If the bleeding is from a moderate-sized vessel, it may be sufficient to wash out the wound with hot lotion, and after sponging it with pure carbolic acid, to plug it tightly with iodoform or double-cyanide gauze.

When a large vessel is involved and when the wound is badly infected and sloughing, it is safer to ligature the main vessel through a fresh incision at a selected point higher up. Should this fail to arrest the hæmorrhage or should the procedure be likely to be followed by gangrene, it may be necessary to amputate the limb well above the infected area. Gangrene is more likely to follow ligature of the main vessels of the lower than of the upper extremity under these conditions, although we have ligatured both the external iliac artery and vein for secondary hæmorrhage without inducing gangrene. In situations where proximal ligature is impossible—for example, in the neck, the groin, or the pelvis—firm plugging with antiseptic gauze may be the only treatment available.

**Constitutional Effects of Hæmorrhage.**—The severity of

the symptoms resulting from hæmorrhage depends as much on the rapidity with which the bleeding takes place as on the amount of blood lost. The sudden loss of a large quantity of blood, whether from an open wound or into a serous cavity — for example, after rupture of the liver or spleen—is attended with marked pallor of the surface of the body and coldness of the skin, especially of the face, feet, and hands. The skin is moist with a cold, clammy sweat, and beads of perspiration stand out on the forehead. The pulse becomes feeble, soft, and rapid, and the patient is faint and listless, and complains of extreme thirst. The temperature is usually subnormal; and the respiration rapid, shallow, and sighing in character. Abnormal visual sensations, in the form of flashes of light or spots before the eyes; and rushing, buzzing, or ringing sounds in the ears are often complained of. The occurrence of post-hæmorrhagic leucocytosis has been already referred to (p. 22).

In extreme cases phenomena which have been aptly described as those of "air hunger" ensue. On account of the small quantity of blood circulating through the body, the tissues are imperfectly oxygenated, and the patient experiences sensations as of suffocation. He is extremely restless, gasps for breath, constantly throws about his arms and bares his chest in the vain attempt to breathe more freely. Faintness and vertigo are marked features. The diminished supply of oxygen to the brain and to the muscles produces muscular twitchings, and sometimes convulsions. Finally, the pupils dilate, the sphincters relax, and death ensues.

Young children stand the loss of blood badly, but they quickly recover as the regeneration of blood takes place rapidly. In old people also, and especially when they are fat, the loss of blood is badly borne, and the ill-effects last longer, and may even be permanent. Women, on the whole, stand loss of blood better than men, and in them the blood is more rapidly replaced.

*Treatment.*—The treatment is practically the same as that of shock. The patient should be placed at rest in a warm, well-ventilated room, and the foot of the bed should be elevated. Cardiac stimulants, such as strychnine or alcohol, must be judiciously administered, over-stimulation being carefully avoided. The inhalation of oxygen has been found useful in relieving the more urgent symptoms of dyspnœa.

The blood may be emptied from the limbs into the vessels of the trunk, where it is more needed, by holding them vertically in the air for a few minutes, and then applying a firm elastic bandage over a layer of cotton wool.

*Introduction of Fluids into the Circulation.*—The most valuable measure for maintaining the circulation, however, is the injection of from one to three pints of ordinary physiological salt solution (a teaspoonful of common salt to a pint of water) into a vein. The solution is sterilised by boiling, and cooled to a temperature of about 105° F. The addition of 5 or 10 minims of adrenalin solution (1 in 1000) is advantageous in raising the blood pressure. It is best introduced into the median basilic (or other superficial) vein, by means of a small glass or metal nozzle to which is attached three or four feet of rubber tubing with a glass funnel at the end of it. All air is expelled from the apparatus by filling it with fluid before connecting it with the vein. The fluid is allowed to flow slowly into the vein—from twenty to thirty minutes being occupied in the process—the pressure being graduated by raising or lowering the funnel. The tube must constantly be kept filled with fluid to avoid the risk of introducing air into the circulation.

One or two pints of saline solution with adrenalin slowly introduced into the rectum, by means of a long rectal tube and a filler, yields eminently satisfactory results. Satisfactory, although less rapidly attained results follow the introduction of saline solution into the cellular tissue—for example, under the mamma, into the axilla, or under the skin of the back.

If the patient can retain fluids taken by the mouth—such as hot coffee, barley water, or soda water—these should be freely given, unless the injury necessitates operative treatment under an anæsthetic.

The injection of blood obtained from a healthy person is sometimes employed in the treatment of pernicious anæmia and other diseases. As it flows from the vein of the donor, the blood is caught in a warm glass dish, and is kept from coagulating by having added to it a five per cent. solution of phosphate of soda (two ounces of the solution to every six ounces of blood). The mixture is then slowly injected into one of the patient's veins, means being taken to keep it at the body temperature. In addition to the fact that it has no advantage over saline injections, the risk of introducing blood-clots and septic organisms, the more elaborate technique, and the frequent difficulty of obtaining a suitable donor of blood, militate against the employment of this method in the treatment of hæmorrhage.

The direct transfusion of blood from one person to another has been entirely superseded by the above methods.

The free administration of fluids by the mouth and a liberal diet of easily digested and readily absorbable food are clearly

indicated. Iron, arsenic, and other hæmatinic drugs are also called for.

### Hæmophilia.

The term hæmophilia is applied to an inherited disease which renders the patient liable to serious hæmorrhage from even the most trivial injuries. Those who suffer from the condition are popularly known as "bleeders."

The essential cause of the disease and its true nature are as yet unknown. There is no proof of any structural defect in the blood-vessels, nor has it been demonstrated that there is any alteration in the chemical composition of the blood.

The disease is in a marked degree hereditary, all the branches of an affected family being liable to suffer. Its mode of transmission to individuals, moreover, is very characteristic: the male members of the stock alone suffer from the affection in its typical form, while the tendency is transmitted through the female line. Thus the daughters of a father who is a bleeder, whilst they do not themselves suffer from the disease, transmit the tendency to their male offspring. The sons, on the other hand, neither suffer themselves nor transmit the disease to their children (Fig. 57).

The disease is met with in boys who are otherwise healthy, and usually manifests itself during the first few years of life. In rare instances profuse hæmorrhage takes place from the umbilical cord. As a rule the first evidence is the occurrence of severe, long-continued, and uncontrollable bleeding from a comparatively slight injury, such as the scratch of a pin, the extraction of a tooth, or a circumcision wound. The blood oozes slowly from the capillaries; at first it appears normal, but after flowing for some days, or it may be weeks, it becomes pale, thin, and watery, and shows less and less tendency to coagulate.

Sometimes the hæmorrhage takes place apparently spontaneously from a mucous surface, such as the gums, the nasal mucous membrane, or the alimentary canal. In other cases the bleeding occurs into the cellular tissue under the skin or mucous membrane, producing large areas of ecchymosis and discoloration. One of the commonest manifestations of the disease is the occurrence of hæmorrhage into the synovial cavities of the large joints, especially the knee, elbow, or hip. The patient suffers repeatedly from such hæmorrhages, the determining injury being often so slight as to have passed unobserved.

There is evidence that the tendency to bleed is greater at

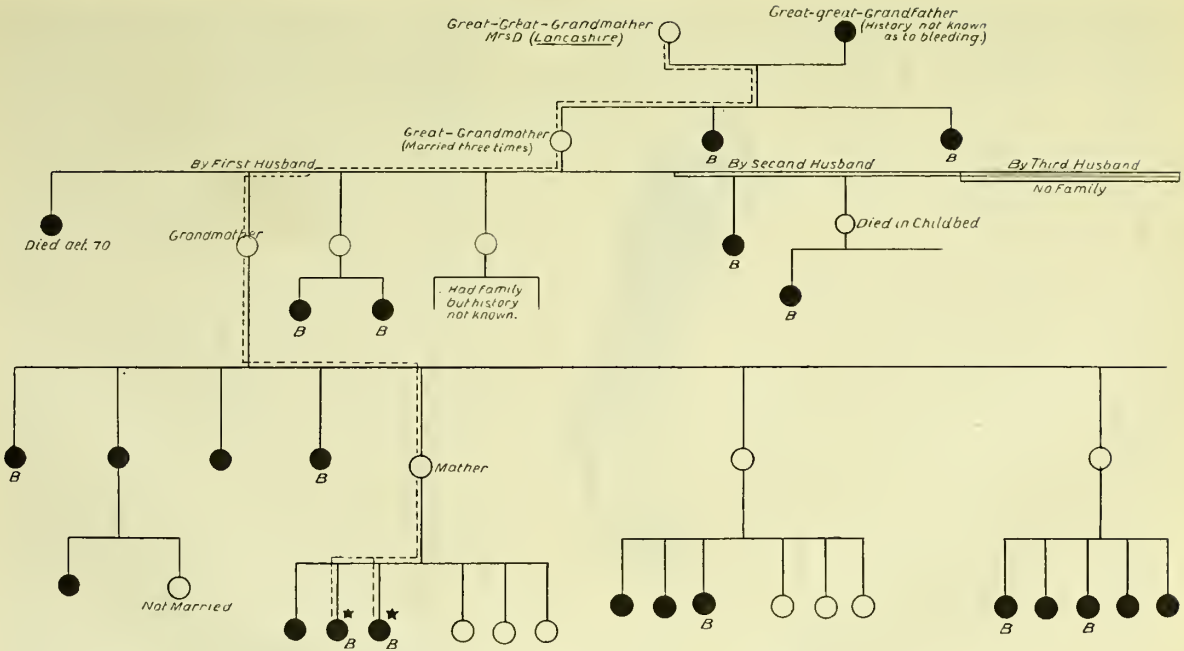



FIG. 57.—Genealogical Tree of Hæmophilic Family.

○ = Females. ● = Males (not bleeders). ●B = Males (bleeders).

* * The patients observed by the authors. The dotted line shows the transmission of the disease to our patients through four generations.

some times than at others—in certain cases showing almost a cyclical character—although nothing is known as to the cause of the variation.

After a severe hæmorrhage into the cellular tissue or into a joint, the patient becomes pale and anæmic, the temperature may rise to 102° or 103° F., the pulse become small and rapid, and hæmic murmurs are sometimes developed over the heart and large arteries. The swelling is tense, fluctuating, and hot, and there is considerable pain and tenderness.

In exceptional cases blisters form over the seat of the effusion, or the skin may even slough, and the clinical features may therefore come to simulate closely those of an acute suppurative condition.

The acute symptoms gradually subside, and the effused blood



Fig. 58.—Extensive subcutaneous Effusion in case of Hæmophilia. The condition simulated Acute Osteomyelitis of Tibia.

is slowly absorbed, the discoloration of the skin passing through the same series of changes as occurs after an ordinary bruise. Prolonged hæmorrhage is usually associated with a subnormal temperature. The patients bear the loss of blood remarkably well, and the blood is rapidly regenerated.

The *diagnosis* is usually easy if the patient or his friends are aware of the family tendency to hæmorrhage and inform the surgeon of it, but they are often very sensitive and reticent regarding the fact, and it may only be elicited after close investigation. It is usually easy to exclude scurvy and purpura from the history. Repeated hæmorrhages into a joint may result in appearances which closely simulate those of tuberculous disease. Recent hæmorrhages into the cellular tissue often present clinical features closely resembling those of acute cellulitis or osteomyelitis (Fig. 58). A careful examination, however, may reveal ecchymoses on other parts of the body which give a clue to the nature of the condition, and may prevent the disastrous consequences which would follow incision of the swelling.

The *prognosis* is, on the whole, unfavourable, as these patients usually succumb sooner or later to hæmorrhage, although they often survive several very severe attacks. After middle life the tendency to bleed appears to diminish.

*Treatment.*—As a rule the ordinary styptics and other means of arresting hæmorrhage are of little avail, and in most cases it is only after trying many remedies that the bleeding ceases.

From among the numerous means suggested for treating this disease the following may be mentioned. The application to the bleeding point of gauze soaked in a 1 in 1000 solution of adrenalin has been found beneficial, as has also the use of the blood of a healthy person applied in the same way. The prolonged inhalation of oxygen has recently been recommended. The oozing may be controlled, temporarily at least, by freezing the part with a spray of ethyl-chloride. One or more subcutaneous injections of gelatin may be given—five ounces of a $2\frac{1}{2}$ per cent. solution of white gelatin in normal salt solution being injected at a temperature of about 100° F. In the prophylaxis of hæmophilia, chloride of calcium and extract of thymus gland have been recommended as having the property of increasing the coagulability of the blood, but if the circulation is very weak their use is attended with risk of thrombosis.

## Diseases of Blood-Vessels.

The processes known as thrombosis and embolism are so intimately associated with the diseases of blood-vessels that it is convenient to define these terms in the first instance.

**Thrombosis.**—The term *thrombus* is applied to a clot of blood formed in the interior of the heart or of a blood-vessel, and the process by which such a clot is formed is known as *thrombosis*. The essential cause of thrombosis is as yet not thoroughly understood. It would appear, however, that slowing or stagnation of the blood-stream, and interference with the integrity of the lining membrane of the vessel wall, are the most important factors determining the formation of the clot. When the thrombus is formed slowly it is of a greyish-white colour, and, being deposited in successive layers, has a distinctly laminated appearance on section. This is known as a *white thrombus* or laminated clot, and is often met with in the sac of an aneurysm (Fig. 65). When rapidly formed in a vessel in which the blood is almost stagnant—as, for example, in a large varicose vein—the blood coagulates *en masse* and the clot consists of all the elements of the blood, constituting a *red thrombus*. Sometimes the

thrombus is mixed—a red thrombus being deposited on a white one, it may be in alternate layers.

When aseptic, a thrombus usually undergoes organisation by the process already described in relation to the repair of injured blood-vessels. On the other hand, it may degenerate and undergo calcification, or a portion of it may become detached and be carried off in the blood-stream as an embolus.

Occasionally a small thrombus situated behind a valve in a varicose vein or in the terminal end of a dilated vein—for example, in a pile—undergoes calcification, and is then spoken of as a *phlebolith.*

When infected with pyogenic bacteria, the thrombus becomes converted into pus and a localised abscess may form; or portions of the thrombus may be carried as septic emboli in the circulation to distant parts, where they give rise to secondary foci of suppuration—pyæmic abscesses.

**Embolism.**—The term *embolus* is applied to any body carried along in the arterial circulation and ultimately impacted in one of the arteries. This occurrence is known as *embolism.* The commonest forms of embolus are portions of thrombi or of fibrinous formations on the valves of the heart, the latter being usually infected with micro-organisms.

Embolism plays an important part in determining one form of gangrene, as has already been described. Septic emboli are the direct cause of the secondary abscesses which occur in pyæmia; and they are sometimes responsible for the formation of aneurysm.

Portions of malignant tumours also may form emboli, and their impaction in the vessels may lead to the development of secondary growths in distant parts of the body.

Fat and air embolism have already been referred to (pp. 247-254).

### Arteritis.

*Arteritis due to Pyogenic Organisms.*—In arteritis due to pyogenic organisms, the infection may take place by direct spread from a focus of suppuration in the vicinity of the artery, from an imperfectly sterilised ligature applied to the vessel, or from the blood-stream in the form of a septic embolus. The vessel wall undergoes inflammatory softening, and the blood in the lumen may coagulate. The giving way of the wall of a vessel so affected is the chief cause of secondary hæmorrhage. Sometimes the vessel ruptures into an abscess cavity, and dangerous bleeding may occur when the abscess bursts or is opened.

When the inflammation stops short of suppuration, the softening of the vessel wall may lead to aneurysmal dilatation This occurs in embolic arteritis, and is frequently associated with disease of the valves of the heart. It is not uncommon in children, and explains many of the cases of aneurysm met with in young subjects.

*Syphilitic Arteritis.*—The inflammation of arteries associated with syphilis results in marked thickening of the tunica intima, whereby the lumen of the vessel becomes narrowed, or even obliterated—*endarteritis obliterans.* The middle coat usually escapes, but the tunica adventitia is generally thickened. These changes are best seen in the smaller vessels of the brain and of the abdominal viscera, and they cause serious interference with the nutrition of the parts supplied by the affected arteries. In large trunks, by diminishing the elasticity of the vessel wall, they are liable to lead to the formation of an aneurysm.

Changes in the arterial walls closely resembling those of syphilitic arteritis are sometimes met with in *tuberculous* lesions.

*Atheroma.*—This name is applied to certain changes which occur in the deeper layers of the tunica intima whereby an increased development of young connective tissue takes place. In course of time this new tissue undergoes degeneration—at first usually of a fatty nature, but progressing in the direction of calcification.

When this degeneration ensues, lime salts are deposited in the young connective tissue, and calcareous plates or rings form, sometimes over a considerable area of the vessel wall. The endothelium over these plates often disappears, leaving them exposed to the blood-stream, whereby they favour the occurrence of thrombosis.

Changes of a similar kind sometimes occur in the middle coat, the lime salts being deposited among the muscle fibres in concentric rings.

The primary cause of atheroma is not definitely known, but its almost constant occurrence in the aged, to a greater or less degree, suggests that it is of the nature of a senile degeneration. It is favoured by anything which throws excessive strain on the vessel walls, such as heavy muscular work; by chronic alcoholism and syphilis; or by such general diseases as tend to raise the blood pressure—for example, chronic Bright's disease or gout.

It occurs with greater frequency and with greater severity in men than in women. The large arterial trunks are chiefly affected, and the changes are most marked at the arch of the

aorta, opposite the flexures of joints, at the mouths of large branches, and at parts where the vessel lies in contact with bone.

The presence of these calcareous plates in the wall of an artery diminishes its elasticity and favours aneurysmal dilatation. Such a vessel also is liable to be ruptured by external violence and so give rise to traumatic aneurysm. In the smaller vessels atheroma may lead to diminution or even to occlusion of the lumen—a condition which in the limbs predisposes to gangrene. Thrombosis is liable to occur when the plates are exposed in the lumen of the vessel by destruction of the endothelium, and this predisposes to embolism. Atheroma also interferes with the natural arrest of hæmorrhage, and by rendering the vessels brittle, makes it difficult to secure them by ligature. In advanced cases, the accessible arteries—such as the radial, the temporal, or the femoral—may be felt as firm, tortuous cords, which are sometimes so hard that they have been aptly compared to "pipe-stems." The pulse is smaller and less compressible than normal, and the vessel moves bodily with each pulsation. When all the vessels of a limb are affected, the distal parts are cold and wasted, and gangrene is very liable to occur.

**Thrombosis in Veins and Thrombo-Phlebitis.** — Thrombosis is more common in veins than in arteries, probably because the conditions which favour the formation of thrombi —slowing of the blood-stream and irritation of the endothelium of the vessel wall—are, owing to the conditions of the venous circulation, more readily induced in veins.

Venous thrombosis may occur from purely mechanical causes—as, for example, when the wall of a vein is incised, or the vessel included in a ligature, or when it is bruised or crushed by a fragment of a broken bone or by a bandage too tightly applied. Under these conditions the thrombosis is essentially a reparative process, and has already been considered in relation to the repair of blood-vessels.

In other cases thrombosis is associated with certain constitutional diseases—for example, gout and rheumatism; the endothelium of the veins undergoing changes—possibly the result of irritation by abnormal constituents in the blood—which favour the formation of thrombi.

Under these various conditions the formation of a thrombus is not necessarily associated with the action of bacteria, although in any of them this additional factor may be present.

The most common cause of venous thrombosis, however, is inflammation of the wall of the vein—phlebitis.

*Phlebitis.*—Various forms of phlebitis are met with, but for practical purposes they may be divided into two groups—one in which there is little or no tendency towards suppuration; the other in which the suppurative element predominates.

In surgical patients, the *non-suppurative form* is almost invariably met with in the lower extremity, and usually occurs in those who are debilitated and anæmic, and who are confined to bed for prolonged periods—for example, during the treatment of fractures of the leg or pelvis, or after such operations as herniotomy, prostatectomy, or those performed for appendicitis

*Clinical Features.*—The most typical example of this form of phlebitis is that so frequently met with in the internal saphena vein, especially when it is varicose. The onset of the attack is usually indicated by a sudden and severe pain in the lower limb —sometimes below, sometimes above the knee. This initial pain may be associated with shivering or even with a rigor, and the temperature usually rises one or two degrees. There is marked swelling and tenderness along the line of the affected vein, and the skin over it is a dull-red or purple colour. The swollen vein may be felt as a firm cord, with bead-like enlargements in the position of the valves. The patient experiences a feeling of stiffness and tightness through the limb. There is often œdema of the leg and foot, especially when the limb is in the dependent position. The acute symptoms pass off in a few days, but the swelling and tenderness of the vein and the œdema of the limb may last for many weeks.

When the deep veins—iliac, femoral, popliteal—are involved there is usually great swelling of the whole limb, which is of a firm, almost "wooden" consistence, and of a pale-white colour. This is most often seen in puerperal women, and is known as *phlegmasia alba dolens.*

*Treatment.*—The patient must be placed at absolute rest with the foot of the bed raised on blocks ten or twelve inches high and the limb immobilised by sand-bags or splints. It is necessary to avoid handling the parts, lest the clot be displaced and embolism occur. To avoid frequent movement of the limb, the necessary dressings should be kept in position by means of a many-tailed rather than a roller bandage.

To relieve the pain, warm fomentations, or lead and opium lotion, should be applied. Later, glycerin and belladonna, or ichthyol glycerin, may be substituted.

When, at the end of three weeks, the danger of embolism is past, douching and gentle massage may be employed to disperse

the œdema; and when the patient gets up he should wear a supporting elastic bandage.

The *suppurative* form usually begins as a peri-phlebitis arising in connection with some septic focus in the adjacent tissues. The elements of the vessel wall are destroyed by suppuration, and the thrombus in its lumen becomes infected with pyogenic bacteria and undergoes softening. In some cases the organisms reach the thrombus directly from the blood-stream, in others from infected ligatures or instruments—as, for example, in operations for varicose veins or hæmorrhoids.

Portions of the softened thrombus are very liable to become detached and to enter the circulating blood, in which they are carried as septic emboli. These may lodge in distant parts and give rise to secondary foci of suppuration—pyæmic abscesses (p. 69).

*Clinical Features.*—Suppurative phlebitis is most frequently met with in the lateral sinus as a sequel to chronic suppuration in the mastoid antrum and middle ear. It also occurs in relation to the peripheral veins, but in these it can seldom be recognised as a separate entity, being merged in the general septic process from which it takes origin. Its occurrence may be inferred, if in the course of a suppurative lesion there is a sudden rise of temperature, with pain, redness, and swelling along the line of a venous trunk, and a rapidly developed œdema of the limb, with pitting of the skin on pressure. In rare cases a localised abscess forms in the vein and points towards the surface.

*Treatment.*—In the case of the peripheral veins attention must be directed towards the septic condition with which the phlebitis is associated. In some cases—for example, in septic compound fractures—the occurrence of suppurative phlebitis may necessitate amputation of the limb. Ligature of the vein on the cardiac side of the thrombus with a view to preventing embolism is seldom feasible in the peripheral veins, although, as will be pointed out later, the jugular vein may be ligatured with this object in cases of phlebitis of the lateral sinus.

## Varix—Varicose Veins.

The term varix is applied to a condition of veins in which they are so altered in structure that they remain permanently dilated, and are at the same time lengthened and tortuous. Two types of varix are met with: one in which dilatation of a large superficial vein and its tributaries is the most obvious feature; the other, in which bunches of distended and tortuous vessels

develop at one or more points in the course of a vein, a condition to which Virchow applied the term *angioma racemosum venosum*. The two types may occur in combination.

Any vein in the body may become varicose, but the condition is extremely rare except in the veins of the lower extremity, in the veins of the spermatic cord (varicocele), and in the veins at the lower end of the rectum (hæmorrhoids).

Varicocele and hæmorrhoids will be described elsewhere. We are here concerned with varix as it occurs in the veins of the lower extremity.

*Etiology*.—Considerable difference of opinion exists as to the essential cause of varix. The weight of evidence is in favour of the view that, where dilatation is the predominant element, it results from a congenital deficiency in the number, size, and strength of the valves of the affected veins, and in an inherent weakness in the vessel walls.

The second type, the *angioma racemosum venosum*, is probably also due to a congenital alteration in the structure of the vessels, and it is allied to certain of the angiomata. The view that varix is congenital in origin, as was first suggested by Virchow, is supported by the fact that in a large proportion of cases the condition is hereditary: not only may several members of the same family in succeeding generations suffer from varix, but it is often found that the same vein, or segment of a vein, is involved in all of them. The frequent occurrence of the disease in youth is also a strong indication of its congenital origin.

This congenital predisposition may exist without the patient manifesting any of the clinical phenomena associated with varix, and in the majority of cases it is only when some exciting factor comes into operation that these appear.

The most common exciting cause of varicosity is increased pressure within the veins, and this may be produced in a variety of ways. In certain diseases of the heart, lungs, and liver, for example, the venous pressure may be so raised as to cause a localised dilatation of such veins as are congenitally weak. The direct pressure of a tumour or of the gravid uterus, on the large venous trunks in the pelvis, may so obstruct the flow as to distend the veins of the lower extremity. It is a common experience that in women the signs of varix date from an antecedent pregnancy. There is abundant evidence that the importance of the wearing of tight garters as a factor in the production of varicose veins has been much exaggerated, although it must be admitted that this practice is calculated to aggravate

the condition when it is once established. It has been proved experimentally that the backward pressure in the veins may be greatly increased by straining, a fact which helps to explain the frequency with which varicosity occurs in the lower limbs of athletes and of those whose occupation involves repeated and violent muscular efforts. There is reason to believe, moreover, that a sudden strain may, by rupturing the valves and so rendering them incompetent, induce varicosity independently of any congenital defect.

Prolonged standing or walking, by allowing gravity to act on the column of blood in the veins of the lower limbs, is also an important determining factor in the production of varix.



Fig. 59.—Resected portion of Varicose Vein, showing Tortuosity and unequal Dilatation.

Thrombosis of the deep veins—in the leg, for example—may induce marked dilatation of the superficial veins, by throwing an increased amount of work upon them. This is to be looked upon rather as a compensatory hypertrophy of the superficial vessels than as a true varix.

*Morbid Anatomy.*—In the lower extremities, the varicosity most commonly affects the vessels of the internal saphena system; less frequently those of the external saphena system. Sometimes both systems are involved, and abnormally large communicating branches may develop between the two. With the exception of the venæ comites of the posterior tibial and peroneal arteries, the deep veins appear to escape.

The whole length of a vein may be affected, but as a rule the disease is confined to one or more segments of it. These segments are not only dilated, but in many cases are also increased in length, so that they become more or less convoluted. The adjacent loops of the convoluted vein are often bound together by fibrous adhesions. All the coats are thickened, chiefly by an increased development of connective tissue, and in some cases changes similar to those of atheroma occur. The walls of varicose veins are often exceedingly brittle. In

some cases the thickening is uniform, and in others it is irregular, so that here and there thin-walled sacs or pouches project from the side of the vein (Fig. 59). These pouches vary in size from a bean to a hen's egg, the larger forms being called *venous cysts*, and being most commonly met with in the region of the saphenous opening and of the opening in the popliteal fascia. Such pouches, being exposed to injury, are frequently the seat of thrombosis.

The essential anatomical lesion is the absence or deficiency of valves, so that they are incompetent and fail to support the column of blood which bears back upon them. Normally the valves in the femoral and iliac veins and in the inferior vena cava are slightly, if at all, developed, so that in the erect posture the internal saphena receives a large share of the backward pressure of the column of venous blood.

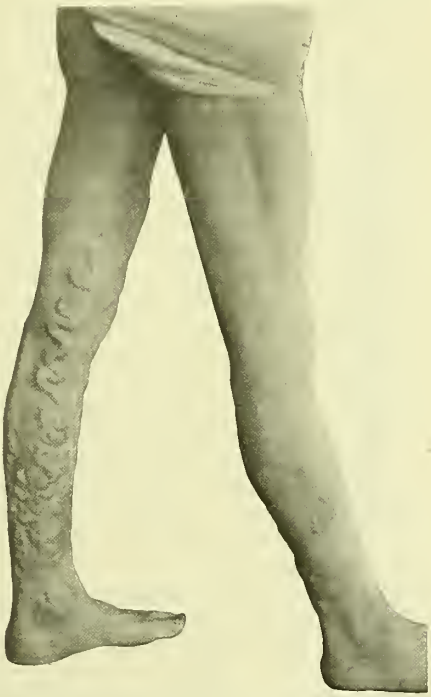


Fig. 60.—Extensive Varix of Internal Saphena System on Left Leg, and slight Varix of External Saphena System on Right Leg.

*Clinical Features.*—The majority of cases are seen in patients between puberty and the age of thirty, and the sexes appear to suffer about equally.

The amount of discomfort caused by varicose veins bears no direct proportion to the degree of varicosity. It depends rather upon the degree of pressure in the veins, as is shown by the fact that it is relieved by elevation of the limb. When the main trunk of the internal saphena is implicated, its valves being incompetent the pressure in the vein is high and the patient suffers a good deal of pain and discomfort. When, on the

contrary, the upper part of the saphena and its valves are intact, and only the more distal veins are involved, the pressure is low and the symptoms are less severe.

The usual complaint is of a sense of weight and fulness in the limb after prolonged standing or walking, sometimes accompanied by actual pain, from which relief is at once obtained by raising the limb. Cramp-like pains are often associated with varix of the deep veins.

The dilated and tortuous vein can be readily seen and felt. Bead-like swellings are sometimes to be detected over the position of the valves in cases of long standing, and on running the fingers along the course of the vessel a firm ridge, due to periphlebitis, may often be detected on each side of the vein. When the limb is œdematous, the outline of the veins is often obscured, but they can be identified on palpation as gutter-like tracks. When large veins are implicated, a distinct impulse on coughing may sometimes be seen to pass down as far as the knee; and if the vessel is sharply percussed a fluid wave may be detected passing both up and down the vein.

If the patient is placed on a couch and the limb elevated, the veins are emptied, and if pressure is then made over the region of the saphenous opening and the patient allowed to stand up, so long as the internal saphena system alone is involved, the veins fill again very slowly from below.

If the external saphena system also is involved, and if communicating branches are dilated, the veins fill up from below more rapidly. When the pressure over the saphenous opening is removed, the blood rapidly rushes into the varicose vessels from above.

The most marked dilatation usually occurs on the inner side of the limb, between the middle of the thigh and the middle of the calf, the arrangement of the veins showing great variety (Figs. 60, 61).

There are usually one or more bunches of enlarged and tortuous veins in the region of the knee, and sometimes at the ankle. Frequently a large branch establishes a communication between the systems of the internal and external saphenous veins in the region of the popliteal space, or across the front of the upper part of the tibia. The superficial position of this last branch and its proximity to the bone render it very liable to injury.

The small veins of the skin often show as fine blue streaks arranged in a stellate or arborescent manner. This is most often observed in women who have borne children.

*Complications.—Chronic eczema and ulcers* are often met with in the lower part of the leg in association with varix, and are due to interference with the nutrition of the skin. The incompetence of the valves allows the pressure in the varicose veins to equal that in the arterioles, so that the capillary circulation is impeded. From the same cause the blood in the deep veins is enabled to enter the superficial veins, where the backward pressure is so great that the blood flows down again, and so a vicious circle is established. The blood therefore loses more and more of its oxygen, and so fails to nourish the tissues.

When the varicosity is of long standing, the skin may become pigmented, assuming a mahogany-brown or bluish hue.

Profuse hæmorrhage may take place from a varicose vein as a result of a wound or of ulceration of its wall. Increased intravenous pressure produced by severe muscular strain may determine rupture of a vein exposed in an ulcer. If the limb is dependent, the incompetency of the valves permits of very rapid and copious bleeding, which may prove fatal, particularly if the patient is intoxicated when the rupture takes place. The bleeding, however, may at once be arrested by elevating the limb, or by applying pressure directly over the bleeding point.



Fig. 61.—Varix of Internal Saphena Vein, with Saccular Dilatation over Saphenous Opening.

*Phlebitis and thrombosis* are common sequelæ of varix, and may prove dangerous, either by spreading into the large venous trunks or by giving rise to emboli. The larger the varix the greater is the tendency for a thrombus to spread upwards and to involve the deeper veins. Thrombi usually originate in venous cysts or pouches, and at acute bends on the vessel, especially when these are situated in the vicinity of the knee, and are subjected to repeated injuries—for example, in riding. In a certain proportion of cases, especially in elderly people, the occurrence of thrombosis leads to cure of the condition by the thrombus becoming organised and obliterating a segment of the vein.

*Treatment.*—At best the treatment of varicose veins is only palliative, as it is obviously impossible to restore to the vessels their normal structure. The patient must avoid wearing anything, such as garters, which constricts the limb, and any obvious cause

of direct pressure on the pelvic veins, such as a tumour, persistent constipation, or an ill-fitting truss, should be removed. Cardiac, renal, or pulmonary causes of venous congestion must also be treated, and the functions of the liver regulated. Severe forms of muscular exertion and prolonged standing or walking are to be avoided, and the patient may with benefit rest the limb in an elevated position for a few hours each day. To support the distended vessels a closely woven silk or worsted stocking, or a light and porous form of elastic bandage, applied as a puttee, should be worn. These appliances should be put on before the patient leaves his bed in the morning, and should only be removed after he lies down again at night. In this way the vessels are never allowed to become dilated. Elastic stockings and bandages made entirely of indiarubber are to be avoided. In early and mild cases these measures are usually sufficient to relieve the patient's discomfort.

In aggravated cases, when the patient is suffering pain, when his occupation is interfered with by repeated attacks of phlebitis, or when there are large pouches on the veins, operative treatment is called for.

The younger the patient the clearer is the indication to operate. It may be necessary to operate to enable a patient to enter any of the public services, even although the condition gives him no trouble.

The operation of Trendelenburg is especially appropriate to cases in which the trunk of the internal saphena vein in the thigh is alone involved. It consists in exposing three or four inches of the vein in its upper part, applying a ligature at the upper and lower ends of the exposed portion, and after carefully tying all tributary branches, resecting this portion of the vein. It is important to include in the resection any large tributary near to the portion to be excised, to prevent it dilating and perpetuating the condition. When the varix is widespread, and especially if several trunks are implicated, it is better to remove several portions of the vein, each about three or four inches long, at intervals along its course. In severe cases the whole length of the varicose vessel may be excised. Mitchell, of Belfast, advises exposing the varices at numerous points by small incisions, and, after clamping the vein between two pairs of forceps, cutting out the intervening portion. Bleeding is prevented, and the edges of the incisions brought into apposition by pressure with pads of gauze; and the limb is firmly bandaged from below upwards and kept in an elevated position. We have frequently employed this method with satisfactory results, but have found it advan-

tageous to close each incision with a single horse-hair stitch. After operation the patient should be confined to bed for not less than three weeks.

The treatment of the complications of varix has already been considered.

## Angiomata.[1]

Tumours of blood-vessels may be divided, according to the nature of the vessels of which they are composed, into the capillary, the venous, and the arterial angiomata.

### Capillary Angioma.

The most common form of capillary angioma is the nævus or congenital telangiectasis.

**Nævus.**—A nævus is a collection of dilated capillaries, the afferent arterioles and the efferent venules of which often share in the dilatation. As is the case with other tumours, little is known regarding the *etiology* of nævi beyond the fact that they are of congenital origin. They are often not noticed until the child is some days old, but attention is usually drawn to them within a fortnight of birth. For practical purposes the most useful classification of nævi is into the cutaneous, the subcutaneous, and the mixed forms.

*The cutaneous nævus*, "mother's mark," or "port-wine stain," consists of an aggregation of dilated capillaries in the substance of the skin. On stretching the skin the vessels may be seen to form a fine network, or to run in leashes parallel to one another. A dilated arteriole or a vein winding about among the capillaries may sometimes be detected. These nævi may occur on any part of the body, but they are most frequently met with on the face. They may be multiple, and vary greatly in size, some being no bigger than a pin-head, while others cover nearly half the surface of the body. In colour they may present every tint from purple to brilliant red; in the majority there is a considerable dash of blue, especially in cold weather.

Unlike the other forms of nævi, the cutaneous variety shows little tendency to disappear, and it is especially persistent when associated with hypertrophy of the skin—*nævoid mole*.

As the nævoid tissue cannot be removed without producing a scar, which in most cases is even more disfiguring than the nævus, *treatment* is very unsatisfactory, and is of no avail except

[1] In the description of angiomata we have followed the teaching of the late John Duncan.

in very small nævi. In these, igni-puncture and escharotics, such as nitric acid, have been successfully employed (p. 284). The X-rays have also yielded satisfactory results in some cases. The use of counter-irritants, such as liniment of iodine, is far from certain in its results.

The purely *subcutaneous* nævus is comparatively rare. It presents, on section, the appearance of a finely reticulated sponge; the walls of the spaces are thin, and are lined by endothelium continuous with that of the blood-vessels. The tumour may

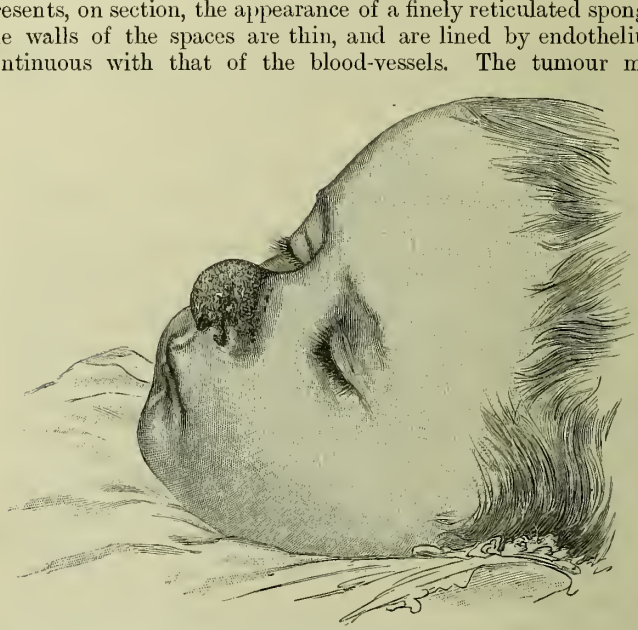


Fig. 62.—Mixed Nævus of Nose which was subsequently cured by Electrolysis.

possess a distinct capsule, especially when it has ceased to grow or is retrogressing.

Although it may be noticed at or within a few days of birth, a subcutaneous nævus is often overlooked, especially when on a covered part of the body, and may not be discovered till the patient is some years old. It forms a rounded, lobulated swelling, seldom of large size, and the skin over it is normal in appearance, or may exhibit a bluish tinge, especially in cold weather. The tumour may be diminished by pressing the blood out of it, but slowly fills again when the pressure is relaxed, and it may swell up when the child struggles or cries.

A subcutaneous nævus has to be diagnosed from other swellings under the skin, such as fatty, cystic, and sarcomatous tumours, cold abscess, and hernia, and when it occurs in the middle line of the face, head, or back, it may be mistaken for meningocele or spina bifida.

*Mixed Nævus.*—As its name indicates, the mixed nævus partakes of the characters of the other two varieties; that is, it is a subcutaneous nævus the skin over which also is nævoid.

It is frequently met with on the face and head, but may occur on any part of the body. It sometimes affects parts covered by mucous membrane, such as the cheek, tongue, and



Fig. 63.—Large Mixed Nævus of Cheek in child æt. 1½; the Skin is only slightly involved. Cured by Electrolysis.

soft palate. The swelling is rounded or lobulated, and projects beyond the level of its surroundings. Sometimes the skin is invaded by the nævoid tissue over the whole extent of the tumour, sometimes only over a limited area (Fig. 63). Frequently the margin only is of a bright-red colour, while the skin over the centre of the swelling resembles a cicatrix. The swelling can be reduced by steady pressure. It increases in size and becomes tense when the child cries.

*Prognosis.*—The rate of growth of the subcutaneous and mixed forms of nævi varies greatly. They sometimes increase very rapidly, especially during the first few months of life; after this they usually grow at the same rate as the child, or more slowly. There is a decided tendency to spontaneous

disappearance of these varieties, fully fifty per cent. undergoing natural cure. This usually begins about the period of the first dentition, sometimes at the second dentition, and sometimes about puberty. On the other hand, an increased activity of growth may be shown at these periods. The onset of natural cure is recognised by the tumour becoming firmer and less compressible, and in the mixed variety, by the colour becoming less bright. Injury, inflammation, or ulceration of the overlying skin may initiate the curative process.

Towards adult life the spaces in a subcutaneous nævus may

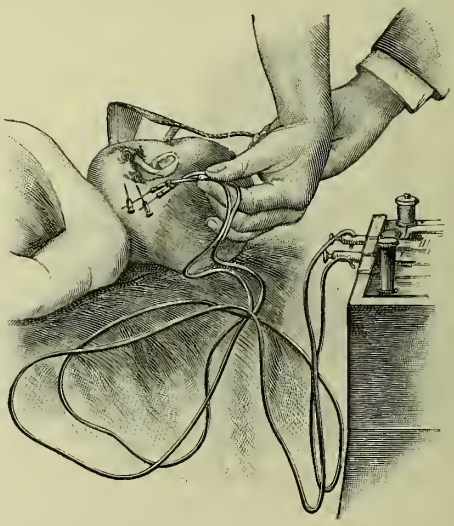


Fig. 64.—Electrolysis of Nævus under Chloroform Anæsthesia. (The galvanometer is not shown in the figure.)

become greatly enlarged, leading to the formation of a cavernous angioma.

*Treatment.*—In view of the frequency with which subcutaneous and mixed nævi disappear spontaneously, active treatment is only called for when the growth of the tumour is out of proportion to that of the child, or when, from its situation —for example, in the vicinity of the eye—any marked increase in its size would render it less amenable to treatment.

The methods of treatment most generally applicable are the use of escharotics, igni-puncture, electrolysis, and excision.

The application of *escharotics* is employed only in very small

nævi occurring on the face. A pointed piece of wood is dipped in strong nitric acid, and then thrust into the centre of the nævoid spot.

For large nævi situated on an exposed part of the body, where it is desirable to avoid a scar, either igni-puncture, or electrolysis is to be preferred. Excision is better when the nævus is on a part covered by the clothes.

*Igni-puncture* consists in making a number of punctures at different parts of the nævus with a fine-pointed Paquelin's thermo-cautery, with the object of starting at each point a process of cicatrisation which extends throughout the nævoid tissue and so obliterates the vessels.

*Electrolysis* acts by decomposing the blood and tissues into their constituent elements—oxygen and acids appearing at the positive, hydrogen and bases at the negative electrode. These substances and gases being given off in a nascent condition, at once enter into new combinations with anything in the vicinity with which they have a chemical affinity. In the nævus the practical result of this reaction is that at the positive pole nitric acid, and at the negative pole caustic potash, both in a state of minute subdivision, make their appearance. The effect on the tissues around the positive pole, therefore, is equivalent to that of an acid cauterisation, and on those round the negative pole to an alkaline cauterisation.

As the process is painful, a general anæsthetic is necessary. The current used should be from 20 to 80 milliampères, gradually increasing from zero, without shock; three to six large Bunsen cells give a sufficient current. Steel needles insulated with vulcanite to within an eighth of an inch of their points are the best. Both poles are introduced into the nævus, the positive being kept fixed at one spot, while the negative is moved about inside the tumour, so as to produce a number of different tracks of cauterisation. On no account must either pole be allowed to come in contact with the skin lest a slough be formed. The duration of the sitting is determined by the effect produced, the average duration being from fifteen to twenty minutes. The object aimed at is to produce hardening of the tumour. If pallor of the skin appears, it indicates that the needles are too near the surface, or that the blood-supply to the integument is being cut off, and is an indication to stop. To cauterise the track and so prevent bleeding, the needles should be slowly withdrawn while the current is flowing. When the skin is reached the current is turned off. The punctures are covered with collodion. Six or eight weeks should be allowed

to elapse before repeating the procedure. From two to eight or ten sittings may be necessary, according to the size and character of the nævus.

*Excision* is to be preferred for nævi of moderate size situated on covered parts of the body, where a scar is of no importance. When only a small proportion of the nævus is cutaneous, the invaded piece of skin may be removed with the tumour. Its chief advantages over electrolysis are that a single operation is sufficient, and that the cure is more speedy and certain. The operation is attended with much less hæmorrhage than might be expected.

**Cavernous Angioma.**—This form of angioma consists of a series of large blood spaces which are usually derived from the dilatation of the capillaries of a subcutaneous nævus. The spaces come to communicate freely with one another by the disappearance of adjacent capillary walls. It may appear at any age from early youth to middle life, and is of very slow growth. The swelling is rounded or oval, and feels not unlike a fatty tumour. There is no pulsation or bruit, and the tumour is but slightly compressible. If interfered with at all they should be removed by excision. Cavernous angiomata are sometimes met with in internal organs.

**Aneurysm by Anastomosis** is the name applied to a vascular tumour in which arteries, veins, and capillaries are all involved. It is met with chiefly on the upper part of the trunk, the neck, and the scalp. It tends gradually to increase in size, and may, after many years, attain an enormous size. The tumour is nodulated, ill-defined, and varies in consistence. It is pulsatile, and a systolic bruit or a "thrilling" murmur may be heard over it. The chief risk is hæmorrhage from injury or ulceration.

The *treatment* is conducted on the same lines as for nævus. When electrolysis is employed, it should be directed towards the afferent vessels; and if it fails to arrest the flow through these, it is useless to persist with it. In some cases ligation of the afferent vessels has been successful.

**Arterial Angioma** or **Cirsoid Aneurysm.**—This is composed entirely of the enlarged branches of an arterial trunk. The condition originates in the smaller branches of an artery—usually the temporal—and may spread to the main trunk; and may even involve branches of other trunks with which the affected artery anastomoses.

The condition is probably congenital in origin, though its appearance is frequently preceded by an injury. It almost

invariably occurs on the head, and is usually met with in adolescents or young adults.

The affected vessels slowly increase in size, and become characteristically tortuous, with narrowings and dilatations here and there. Grooves or gutters are frequently found in the bone underlying the dilated vessels.

There is a constant loud bruit in the tumour, which greatly troubles the patient and may interfere with sleep. There is no tendency either to natural cure or to rupture, but severe, and even fatal, hæmorrhage may follow a wound of the dilated vessels.

The condition may be treated by excision or by electrolysis. In excision the hæmorrhage is controlled by an elastic tourniquet applied horizontally round the head, or by ligature of the feeding trunks. In large tumours the bleeding may be formidable. In many cases electrolysis is to be preferred, and is performed in the same way as for nævus. The positive pole is placed in the centre of the tumour, while the negative is introduced into the main affluents one after another.

## ANEURYSM.

An aneurysm is a sac communicating with an artery, and containing fluid or coagulated blood.

Two types of aneurysm are met with—the pathological, and the traumatic. It is convenient to describe in this section also certain conditions in which there is an abnormal communication between an artery and a vein—arterio-venous aneurysm.

### Pathological Aneurysm.

In this class are included such aneurysms as are produced by gradual dilatation of an artery, resulting from weakening of its coats, combined, in most cases, with a loss of elasticity in the walls and a marked increase in the arterial tension. In the majority of cases the weakening of the artery and the diminution of the normal elasticity of its wall are due to atheroma. In other cases the vessel wall is softened by arteritis—especially the embolic form—so that it yields before the pressure of the blood.

Repeated and sudden raising of the arterial tension, as a result, for example, of violent muscular efforts or of frequent excessive indulgence in alcohol, plays an important part in

the causation of aneurysm. These factors probably explain the comparative frequency of aneurysm in those who follow such arduous occupations as soldiers, sailors, dock-labourers, and navvies. In these classes the condition usually manifests itself between the ages of thirty and fifty—that is, when the vessels are beginning to degenerate, although the heart is still vigorous and the individuals are hard at work. The comparative immunity of women may also be explained by the less severe muscular strain involved by their occupations and recreations. Any cause which persistently increases the vascular tension also favours aneurysm formation—for example, plethora, chronic alcoholism, gout, or chronic Bright's disease.

Syphilis plays an important part in the production of aneurysm, but the precise way in which it acts is doubtful. It may be that it predisposes the patient to atheroma, and induces a persistent increase in the vascular tension from loss of elasticity of the vessel wall and narrowing of the lumen as a result of syphilitic arteritis. It is a striking fact that aneurysm is seldom met with in women who have not suffered from syphilis.

*Varieties.*—Different varieties of pathological aneurysm occur, according as the weakening of the arterial wall is general over a considerable segment of the artery, or is localised in one or more limited areas.

**Fusiform Aneurysm.**—When the whole circumference of a portion of an artery has been weakened, the tension of the blood causes the walls to dilate uniformly, so that a fusiform or tubular aneurysm results. All the coats of the vessel are stretched and form the sac of the aneurysm, and the affected portion is not only dilated but is also increased in length. This form is chiefly met with in the arch of the aorta, but may occur in any of the main arterial trunks. As the sac of the aneurysm includes all three coats, and as the inner and outer coats are usually thickened by the deposit in them of connective tissue, a fusiform aneurysm increases in size very slowly and seldom gives rise to urgent symptoms.

When the intima is roughened by atheroma, especially in the form of calcareous plates, shreds of clot may adhere to it, but as a rule a fusiform aneurysm contains only fluid blood.

Natural cure is occasionally effected by the emerging artery becoming occluded by a clot.

**Sacculated Aneurysm.**—When a limited area of the vessel wall is weakened—for example, by atheroma or by other form of arteritis—this portion yields before the pressure of the blood, and a sacculated aneurysm results. The intima and

media being already damaged, or, it may be, destroyed, by the primary disease, the stress falls on the adventitia, which in the majority of cases constitutes the sac. To withstand the pressure the outer coat becomes thickened, and as the aneurysm increases in size it forms adhesions to surrounding tissues, so that fasciæ, tendons, nerves, and other structures may be found matted together in the wall of the aneurysm. The wall is further strengthened by the deposit on its inner aspect of blood-clot, which may eventually become organised.

The contents of the aneurysmal sac consist of fluid blood, and a varying amount of blood-clot which is deposited in concentric layers on the inner aspect of the sac, constituting a laminated clot. Near the blood current the clot is soft, red,

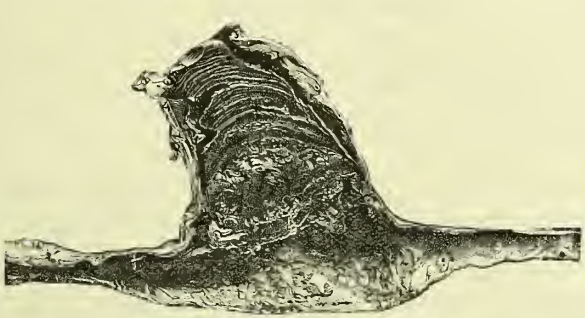


FIG. 65.—Sacculated Aneurysm of Abdominal Aorta nearly filled with laminated clot. Note greater density of clot towards periphery.

and friable; while near the wall it is pale and firm (Fig. 65). The laminated clot not only strengthens the sac, enabling it to resist the blood pressure and so prevent rupture, but, if it increases sufficiently to fill the cavity, may bring about cure. The principle upon which all methods of treatment are based is to imitate nature in producing such a clot.

An aneurysm is said to be *diffused* when the sac ruptures and the blood escapes into the surrounding tissues.

When one or more of the coats of the artery enter into the formation of the sac, the aneurysm is sometimes called a "true aneurysm"; while the term "false" is applied when all the coats have given way and the sac is formed entirely by condensation of the surrounding structures. These terms, however, have been used in so many different senses, and are in themselves so misleading, that we do not employ them.

**Dissecting Aneurysm.**—The blood may force its way

between the coats of the vessel—sometimes between the intima and media, but usually into the substance of the media—and so form a cul-de-sac in the substance of the vessel wall. This is spoken of as a dissecting aneurysm. In as much as it always originates in the aorta, and is confined to the large branches in the thorax and abdomen, this variety of aneurysm has no surgical importance.

**Clinical Features of Aneurysm.**—Surgically, the sacculated is by far the most important variety of aneurysm. The outstanding clinical feature is the existence in the line of an artery of a more or less globular swelling, which pulsates, and with each pulsation expands. The expansion is detected by observing that when both hands are placed over the swelling they are separated with each beat of the heart. If the main artery be compressed on the cardiac side of the swelling, the pulsation is arrested and the tumour becomes smaller and less tense, and it may be still further reduced in size by making gentle pressure over it so as to empty it of fluid blood. On allowing the blood again to flow through the artery, after one or two beats of the heart the sac fills up and the expansile pulsation returns. In most cases a distinct thrill is felt on placing the hand over the swelling, and a blowing, systolic murmur may be heard with the stethoscope. It is to be borne in mind that occasionally, when the interchange of blood between an aneurysm and the artery from which it arises is small, pulsation and bruit may be very slight or even absent. This is also the case when the sac contains a considerable quantity of clot. When it becomes filled with clot (*consolidated aneurysm*) these signs disappear, and the clinical features are those of a solid tumour lying in contact with an artery.

A comparison of the pulse in the artery beyond the seat of the aneurysm with that in the artery on the healthy side, shows that on the affected side the wave is smaller in volume, and somewhat delayed in time. A pulse tracing shows that the normal impulse and dicrotic waves are lost, and that the force and rapidity of the tidal wave are diminished.

An aneurysm exerts pressure on the surrounding parts, which are usually thickened and adherent to it and to one another. Adjacent veins may be so compressed that congestion and œdema of the parts beyond are produced. Pain, disturbances of sensation, and muscular paralyses may result from pressure on nerves. Considerable portions of bone may undergo atrophy and be absorbed by the gradually increasing pressure, as is most typically seen in the sternum and vertebræ. Cartilage, on the

other hand, yields before the pressure, so that the intervertebral discs or the costal cartilages may escape while the adjacent bones are destroyed. The skin over the aneurysm gradually becomes thinned and stretched, until finally a slough forms, and when it separates hæmorrhage takes place.

Pain is a variable symptom. It may be due to the extreme tension in and around the aneurysm, and to the pressure exerted on sensitive structures, in which case it is of a constant, dull, boring character. When due to direct pressure on nerve trunks it is sharp and lancinating.

*Differential Diagnosis.*—Aneurysm is to be diagnosed from other pulsatile swellings. Sometimes pulsation is transmitted from a large artery to a new growth, a mass of enlarged lymphatic glands, or an inflammatory swelling which lies in its vicinity; or a tumour may actually pulsate in virtue of its extreme vascularity, but in neither case is the pulsation expansile as in aneurysm—a most important point in differential diagnosis. The swelling may, by appropriate manipulation, be moved from the artery in some cases and the pulsation ceases. Compression of the artery on the cardiac side of the swelling, although it arrests the pulsation, does not produce any diminution in the size or tension of the swelling, and when the pressure is removed the pulsation is restored immediately.

Fluid tumours overlying an artery, such as cysts, abscesses, or enlarged bursæ, may simulate aneurysm very closely. An apparent expansion may accompany the pulsation, but careful examination usually enables this to be distinguished from the marked expansion of an aneurysm. Compression of the artery makes no difference in the size or tension of the swelling.

Vascular tumours, such as sarcomata and goitres, may yield an expansile pulsation, but they differ from an aneurysm in that they are not diminished in size by compression of the main artery, nor can they be emptied by pressure. A soft, whiffing bruit is sometimes to be detected in certain parts of these tumours.

The exaggerated pulsation sometimes observed in a normal artery—for example, the "pulsating aorta" so often seen in women who suffer from dyspeptic symptoms—should not be mistaken for that of an aneurysm.

*Prognosis.*—While an aneurysm may remain stationary for a long period, it may at any time undergo spontaneous cure.

*Natural cure* is usually brought about by the formation in the aneurysm of laminated clot, which gradually increases in

amount till it fills the sac. On the other hand, a portion of clot in the sac may be separated and become impacted as an embolus in the artery beyond, leading to thrombosis which first occludes the artery and then extends into the sac.

The progress of natural cure is indicated clinically by the aneurysm becoming smaller, firmer, less expansile, and less compressible. The murmur and thrill are also diminished, and the pressure effects of the aneurysm become less marked. When the cure is complete the pulsation is lost, and there remains a firm swelling attached to the vessel (*consolidated aneurysm*). While these changes are taking place the collateral arteries become enlarged, and an anastomotic circulation is established.

An aneurysm may prove *fatal* by exerting pressure on important structures adjacent to it, by causing syncope, by rupture, or from the occurrence of suppuration. *Pressure* symptoms are usually most serious from aneurysms situated in the neck, thorax, or skull. Sudden fatal *syncope* is not infrequent in cases of aortic and other large aneurysms.

*Rupture* may take place through the skin, on a mucous or serous surface, or into the cellular tissue. The first hæmorrhage is often comparatively slight and stops naturally, but it soon recurs, and is so profuse, especially when the blood escapes externally or into a large cavity, that it rapidly proves fatal. When the bleeding takes place into the cellular tissue the aneurysm is said to become *diffused*, and the extravasated blood may spread widely through the tissues, exerting great pressure on the surrounding structures.

The *clinical features* associated with rupture of an aneurysm are sudden and severe pain in the part, while the patient becomes pale, cold, and faint. If a comparatively small escape of blood takes place into the tissues, the sudden alteration in the size, shape, and tension of the aneurysm, together with a loss of pulsation, may be the only local signs. When the bleeding is profuse, however, the parts beyond the aneurysm become greatly swollen, livid, and cold, and the pulses as a rule are completely lost. At the same time the characteristic signs of aneurysm disappear. The arrest of the blood-supply may result in gangrene. Sometimes the pressure of the extravasated blood causes the skin to give way and fatal hæmorrhage results.

The *treatment* is carried out on the same lines as for a ruptured artery (p. 251), the main object being to avert gangrene of the limb. Should this ensue amputation is called for.

*Suppuration* may occur in the vicinity of an aneurysm as a result of infection with pyogenic bacteria. The signs of acute inflammation and suppuration are added to those peculiar to aneurysm. The aneurysm may burst into the abscess, so that when the latter points the pus is mixed with broken-down blood-clot, and finally free hæmorrhage takes place. It has more than once happened that even the most eminent surgeons have incised such abscesses without having recognised their association with aneurysm, with tragic results.

**Treatment.**—The numerous surgical measures employed in the treatment of aneurysm are all designed to imitate the process of natural cure.

In treating a case of aneurysm the indications are: to promote the coagulability of the blood, and so to favour the formation of a clot in the sac; and to obtain a permanent occlusion of the portion of the artery from which the aneurysm springs, without at the same time seriously endangering the nutrition of the parts beyond. General constitutional treatment effects certain of these objects, while others are attained by local measures.

*Constitutional Treatment.*—All forms of local treatment must be supplemented by general measures which tend to reduce the arterial tension and to diminish the force of the heart's action. The patient must be kept in bed at absolute rest—muscular effort being as far as possible avoided. A dry and non-stimulating diet is indicated, the quantity being gradually reduced till it is just sufficient to maintain nutrition. Saline purges may be employed to reduce the vascular tension. The benefit derived from the administration of potassium iodide administered in full doses, as first recommended by George W. Balfour, probably depends on its depressing action on the heart. Pain or restlessness may call for the use of moderate doses of opium.

*Local Treatment.*—The constitutional treatment above described is only to be looked upon as accessory to local measures, by which alone the permanent occlusion of the artery and the obliteration of the sac can be effected.

*The Old Operation.*—The procedure which goes by this name consists in exposing the aneurysm, clearing out the clots, and ligating the artery above and below the sac. In some instances the sac is then dissected out and removed; in others it is left to contract. Where it is available this is the most radical and the most certain method of treatment. Originally practised by Antyllus (A.D. 300)—hence the name "old

operation"—the procedure was revived by Syme, and has been widely practised by Annandale and others. This method is particularly suitable to all forms of sacculated aneurysm of the limbs, so long as they are tolerably circumscribed and free from complications. It has been successfully practised also in subclavian, carotid, and external iliac aneurysms. It is not appropriate to cases in which there is advanced atheroma of the artery above and below the sac.

In the neck and in other situations where a tourniquet cannot be employed, the sac must be incised, and a finger quickly passed into the lumen of the artery so as to plug it and prevent bleeding while the clots are being turned out and the ligatures applied. The risk from hæmorrhage renders this one of the most formidable operations of surgery.

In the limbs, the circulation is controlled by a tourniquet—preferably that of Petit which can be rapidly slackened and tightened as may be necessary. The aneurysm is freely exposed, and, after the vessel has been ligatured above and below, the sac is opened and the clots turned out. The sac is then dissected away, any vessels coming off from it being ligatured, or it is left to contract according to circumtances. If the vein is adherent to the sac, as is frequently the case, the adherent portion may be removed. Experience proves that the removal of a limited portion of both artery and vein at the same time is not necessarily followed by gangrene, so long as infection is excluded.

When, on account of adhesions, there is difficulty in applying the ligature to the artery after opening and emptying the sac, a bougie may be passed into the lumen of the vessel and the ligature thrown round it with the aid of an aneurysm needle, the bougie being withdrawn as the ligature is tightened (Annandale). This manœuvre may be repeated at the distal end.

Matas has suggested that, in the case of a sacculated aneurysm, after clearing out the clots, the communication between the artery and the sac should be closed by a series of interrupted sutures passed through the middle and outer coats of the vessel as in arteriorraphy, so as to retain the channel of the artery. The empty sac is then folded over the line of suture, and the cavity obliterated by stitching its walls together. In fusiform aneurysm a rubber tube is temporarily placed in the two openings and along the groove between them, and over this the adjacent part of the sac is sutured as in Witzel's gastrostomy, the tube being withdrawn before the last sutures are tightened.

*Ligation of the Artery.*—The principle of this operation is to arrest, or so far to diminish, the flow of blood through the aneurysmal part of the artery that coagulation takes place in the sac and the clot spreads to the artery and occludes it.

The ligature may be applied on the cardiac side of the aneurysm, either immediately above the sac (Anel's operation, 1710) or at some distance above (John Hunter, 1785).

On the other hand, one or more branches may be ligatured on the distal side of the aneurysm, so as totally to arrest the flow through the sac (Brasdor's operation, 1760)—for example, in aneurysm of the proximal end of the common carotid the vessel may be ligatured near its bifurcation. The distal operation may also be performed, merely to diminish the quantity of blood passing through the affected artery without completely stopping the stream (Wardrop's operation, 1825)—for example, in innominate aneurysm the common carotid and third part of the subclavian may be ligatured, the branches of the first part of the subclavian not being interfered with.

Anel's operation—proximal ligature close to the sac—has been practically abandoned, as the cases to which it is suitable can be treated with greater safety and certainty by the old operation.

The advantages of Hunter's operation have been largely discounted by the employment of antiseptic methods of operating. Its chief claim is its simplicity, the ligature being applied to a healthy part of the artery whose relations are undisturbed by the proximity of the aneurysm—for example, ligature of the femoral in Scarpa's triangle or in Hunter's canal, for popliteal aneurysm.

By this method the cure is not certain as the distance between the seat of ligature and the sac favours the establishment of a collateral circulation through intervening branches, and this, while it diminishes the risk of gangrene, permits the access of fresh blood to the aneurysm before there is time for an occluding clot to be formed. Even when a clot forms it may be only temporary, and may disappear, so that pulsation in the sac returns. This "recurrent pulsation" after ligature of an artery may be due to imperfect occlusion of the vessel at the seat of ligature, to the rapid establishment of a free collateral circulation, or to the reabsorption of the clot which temporarily occluded the artery.

*Ligation of an artery in its continuity* is performed through an incision which usually runs in the long axis of the vessel. The part of the artery to which the ligature is to be applied

is exposed by dissection, care being taken to avoid opening up the cellular planes more than is absolutely necessary. The vessel is recognised by its pulsation, and a portion sufficiently cleared of its sheath to enable the aneurysm needle to be passed without force. The wall of the vessel should be disturbed as little as possible, to avoid damaging the vasa vasorum through which it is nourished. The needle—threaded or unthreaded according to circumstances—is passed round the vessel from the side on which the most important structures lie. Where there is a single large vein accompanying the artery the needle is passed from the side on which the vein lies. Where there are venæ comites the presence of a nerve trunk on one or other side will determine the direction in which the needle is passed. The ligature—silk or chromicised catgut—is tied in a reef knot or in a stay knot. A stay knot consists of two ligatures applied side by side, each having the first turn of a reef knot tied separately. The two ends on each side are then used as a single cord with which to make the second turn of the reef knot (Ballance and Edmunds). The wound is sutured without drainage.

The *after treatment* consists in wrapping the limb in cotton wool to conserve its heat, and elevating it sufficiently to promote the venous return, without at the same time impeding the arterial flow — a similar line of treatment to that already described in connection with ruptured arteries (p. 251).

*Compression.*—With a view to promoting coagulation in the sac, the circulation may be temporarily arrested by compressing the artery on the cardiac side of the aneurysm. To be efficient the compression must be kept up continuously for several hours, and this is best accomplished by digital pressure applied over a superficial part of the vessel where it overlies a bone. Digital compression is chiefly applicable to aneurysm of the superficial femoral and popliteal arteries.

The results, however, are so uncertain, that the procedure has been given up almost entirely.

*Flexion.*—In small and slowly growing aneurysms at the bend of the elbow or in the popliteal space, the circulation may be arrested and coagulation induced by flexing the joint so that the sac is pressed against the artery, and the artery slightly kinked. Before being flexed the limb is bandaged up to the level of the aneurysm. The flexed attitude is maintained for several hours. This method may be employed alone, or as an adjuvant to others, as, for example, when pulsation threatens to return after the artery has been ligated.

*Reid's Method by Elastic Bandage.*—In aneurysms of the limbs the principle of compression may be applied after the method of Reid. An elastic bandage is firmly applied from the fingers or toes to just below the aneurysm. It is lightly applied as it passes over the swelling, and again tightened above. As the circulation through the limb is thus completely arrested, the bandage must not be left on for more than an hour, for fear of inducing gangrene. As the bandage is being removed the artery should be controlled by digital pressure to prevent a sudden inflow of blood disturbing the clot which may have formed. This pressure should be maintained for some hours.

In view of the uncertainty of the results, the discomfort to the patient, and the trouble involved in carrying out these various methods of compression, the application of a ligature—which is merely another way of carrying out the same principle—is usually preferable.

*Other Methods of Treatment.*—In internal aneurysms—for example, innominate and aortic—and in such external aneurysms as gluteal, sciatic, or vertebral, which are so situated that the methods already described are impracticable, one or other of the following measures may be employed.

*Macewen's acupuncture or "needling" method* consists in passing one or more fine, highly tempered steel needles through the tissues overlying the aneurysm, and through its outer wall. The needles are made to touch the opposite wall of the sac, and the pulsation of the aneurysm imparts a movement to them which causes them to scarify the inner surface of the sac. The blood coagulates on the rough surface produced, and the clot thus formed increases in size till it may fill the sac. As much of the inner aspect of the sac as can be reached should be scarified in this way, to increase the area of clot formation and to render the clot uniformly thick. The needles may be left in position for some hours, the projecting ends being surrounded with sterile gauze.

*Electrolysis* is applied to an aneurysm in the same way as to a nævus. The insulated needles are passed in the same way as Macewen's needles, and the results seem to be best when the needle is made to scratch the wall of the sac—a combination of "needling" and galvano-puncture.

The *Moore-Corradi method* consists in introducing through the wall of the aneurysm a hollow insulated needle, through the lumen of which from ten to twenty feet of highly drawn silver or other wire is passed into the sac, where it coils up into an open meshwork. The positive pole of a galvanic battery is

attached to the wire, while the negative pole is placed over the patient's back. A current, varying in strength from twenty to seventy milliampères, is allowed to flow for about an hour. The hollow needle is then withdrawn, but the wire is left *in situ*. The results are somewhat similar to those obtained by needling and by electrolysis, but the clot formed on the large coil of wire is more extensive.

*Subcutaneous Injections of Gelatin.*—This method of treating inoperable cases of sacculated aneurysm is still on its trial. It is based on the fact that a solution of gelatin introduced into the circulation increases the coagulability of the blood. Three or four ounces of a two per cent. solution of white gelatin in sterilised water, at a temperature of about 100° F., are injected into the subcutaneous tissue of the abdomen every two, three, or four days. In the course of a fortnight or three weeks improvement may begin. The clot which forms is liable to soften and be absorbed, but a repetition of injections has in several cases established a permanent cure.

In rare cases *amputation* is the only treatment which offers a prospect of saving life. It is indicated chiefly in cases complicated by suppuration, by secondary hæmorrhage after excision or ligature, or by gangrene. Amputation beyond the aneurysm has been performed as a means of arresting the blood-flow through the sac, and so effecting a cure—for example, amputation at the shoulder for subclavian aneurysm (Fergusson).

The method of treatment to be selected for any given case of aneurysm depends greatly on the general health of the patient, and on the variety, site, and condition of the aneurysm, and will be considered apropos of aneurysms of individual arteries.

## Traumatic Aneurysm.

The essential feature of a traumatic aneurysm is that it is produced by some form of injury which divides all the coats of the artery. The walls of the injured vessel are usually healthy, but they form no part of the sac of the aneurysm. The sac consists of the condensed and thickened soft tissues which surround the artery.

The injury to the artery may be of the nature of a subcutaneous wound or tear, such as is produced by the fragments of a broken bone, or it may be a punctured wound from a stab or cut. Only small wounds of arteries give rise to traumatic aneurysm, as extensive wounds are attended with a sudden and profuse hæmorrhage into the cellular tissue which shows no

tendency to become limited. These have already been described under ruptured artery.

The aneurysm may form soon after the injury is inflicted, and before the wound in the wall cicatrises. Blood slowly escapes into the surrounding tissues, gradually displacing and condensing them, until they form a distinct sac enclosing the effused blood. Towards the periphery the blood coagulates, and, being under considerable pressure, the clot becomes condensed.

Less frequently a traumatic aneurysm forms some considerable time after the injury, from gradual stretching of the fibrous cicatrix by which the wound in the wall of the artery has been closed. The gradual stretching of this cicatrix results in condensation of the surrounding structures which form the sac, on the inner aspect of which laminated clot is deposited.



Fig. 66.—Traumatic Aneurysm of Brachial Artery, in girl æt. 16, caused by stab with pen-knife.

A traumatic aneurysm is almost always sacculated, and, so long as it remains circumscribed, has the same characters as a pathological sacculated aneurysm, with the addition that there may be external evidence of a wound. A traumatic aneurysm is very liable to rupture and become diffuse—a change which may result in bringing about a cure.

The treatment is governed by the same principles as apply to the pathological varieties. The walls of the artery being healthy, operative measures dealing with the sac and its feeding arteries are to be preferred.

### Arterio-Venous Aneurysm.

An abnormal communication between an artery and a vein constitutes an arterio-venous aneurysm. Two varieties are recognised—one in which the communication is direct (*aneurysmal varix*) (Fig. 67); the other in which the vein communicates with the artery through the medium of an aneurysmal sac (*varicose aneurysm*) (Fig. 68).

Either variety may result from pathological causes, but in the vast majority of cases they are traumatic in origin, being

due to such injuries as stabs, punctured wounds, and gun-shot injuries which involve both artery and vein. In former times the most common situation was at the bend of the elbow, the brachial artery having been accidentally punctured in performing phlebotomy of the median basilic vein. Arterio-venous aneurysm is a frequent result of injuries by modern high-velocity bullets.

Both in aneurysmal varix and in varicose aneurysm the higher blood pressure in the artery forces arterial blood into the

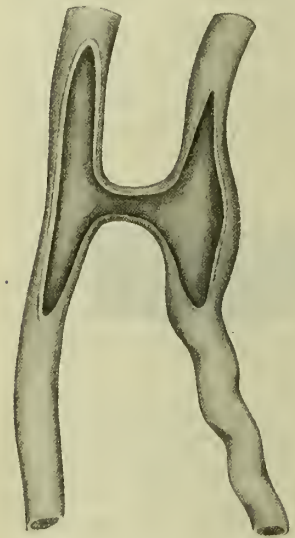


FIG. 67.—Diagram of Aneurysmal Varix.

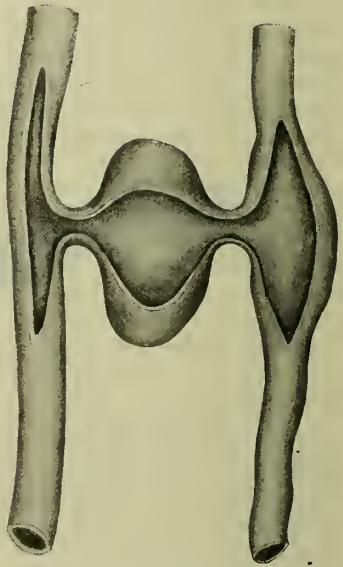


FIG. 68.—Diagram of Varicose Aneurysm.

veins, which become distended and thickened, and in course of time assume certain of the characters of varicose veins.

In *aneurysmal varix* (Fig. 67) the vein near the point of communication with the artery tends to become dilated, and to form a thick-walled sac, beyond which the vessel and its tributaries are distended and tortuous. The free flow of arterial blood through this varicose vessel makes it pulsate, and produces in it a marked vibratory thrill and a loud murmur. In addition to these characters, the clinical features of aneurysmal varix closely resemble those associated with varicose veins. The tendency of the varix is to remain stationary. Rupture is exceedingly rare.

In many cases, the support of an elastic bandage is all that is necessary in the way of treatment, but when the condition causes serious inconvenience, an attempt may be made to separate the vessels and to close the opening in each by a fine suture, and, if this is impossible, the artery should be ligatured above and below the point of communication.

*Varicose aneurysm* (Fig. 68) usually develops in relation to a traumatic aneurysm, the vein involved having formed adhesions with the sac, and ultimately opened into it. In this way a communication between the artery and the vein is established, and the clinical features are those of a combination of traumatic aneurysm and aneurysmal varix.

As there is little tendency to spontaneous cure, and as the aneurysm is liable to increase in size and finally to rupture, operative treatment is usually called for. This consists in applying a ligature to the artery above and below the point of communication, and at the same time incising the sac, turning out the clots, and ligaturing any branches which happen to open into the sac. The vein should not be ligatured unless it is absolutely necessary.

## ANEURYSMS OF INDIVIDUAL ARTERIES.

After what has been said of aneurysm in general, it is only necessary to refer very briefly to the more salient points bearing on aneurysms as they occur in individual arteries. To avoid repetition, it may be stated that in the treatment of all aneurysms local measures are supplemented by the employment of the general constitutional treatment already described. It may also be assumed that while the measures mentioned as suitable to each of the special aneurysms are to be preferred, circumstances may make it necessary to have recourse to one of the other procedures already mentioned. No hard-and-fast rules can be laid down for the treatment of a condition which varies so widely in different cases.

**Thoracic Aneurysm.**—The arch of the aorta is the most common seat of aneurysm, but surgical treatment is rarely called for.

All varieties of aneurysm occur in the aorta, the fusiform being the most common. Frequently a sacculated aneurysm springs from a fusiform dilatation.

The *clinical features* depend chiefly on the direction in which the aneurysm enlarges, and are not always well marked even

when the swelling is of considerable size. They consist in a pulsatile swelling—sometimes in the episternal notch, but usually towards the right side of the sternum—with an increased area of dulness on percussion. With the X-rays a dark shadow is seen corresponding to the swelling. Pain is usually a prominent symptom, and is largely referable to the pressure of the aneurysm on the vertebral column or the sternum, causing erosion of these bones. Pressure on the thoracic veins or on the air-passages may cause cyanosis and dyspnœa. When the œsophagus is pressed upon the patient may have difficulty in swallowing. The left recurrent laryngeal nerve may be stretched or pressed upon as it hooks round the arch of the aorta, and hoarseness of the voice and a characteristic "brassy" cough may result from paralysis of the muscles of the larynx which it supplies. The vagus, the phrenic, and the spinal nerves may also be pressed upon. When the aneurysm is on the transverse part of the arch the trachea is pulled down with each beat of the heart—a clinical phenomenon known as the "tracheal tug." Aneurysm of the descending thoracic aorta may, after having eroded the bodies of the vertebræ and posterior portions of the ribs, form a swelling in the back to the left of the vertebral column.

The surgical methods of *treatment* for thoracic aneurysm are merely palliative, and are designed to avert rupture. Needling, electrolysis, the Moore-Corradi method, and the subcutaneous injection of gelatin have all been employed with this object. Christopher Heath obtained some success in aneurysm of the transverse part of the aortic arch, from ligature of the left common carotid.

**Abdominal Aneurysm.**—Aneurysm is much less frequent in the abdominal than in the thoracic aorta. While any of the large branches in the abdomen may be affected, the most common seats are just above the origin of the cœliac axis, and at the bifurcation of the aorta.

The *clinical features* vary with the site of the aneurysm and with its rapidity and direction of growth. A smooth, rounded swelling, which exhibits expansile pulsation forms, usually towards the left of the middle line. It may extend upwards under cover of the ribs, downwards towards the pelvis, or backwards towards the lumbar region. On palpation a systolic thrill may be detected, but the presence of a murmur is neither constant nor characteristic. Pain is usually present; it may be neuralgic in character, or may simulate renal colic. When the aneurysm presses on the vertebræ and erodes them, the symptoms may closely simulate those of spinal caries, particularly if, as

sometimes happens, symptoms of compression paraplegia ensue. In its growth the swelling may press upon and displace the adjacent viscera, and so interfere with their functions.

The *diagnosis* has to be made from solid or cystic tumours overlying the artery; from a "pulsating aorta"; and from spinal caries. The use of the X-rays is sometimes helpful.

The condition usually proves fatal, either by the abscess bursting suddenly into the peritoneal cavity, or by slow leakage into the retro-peritoneal tissue.

Electrolysis and the Moore-Corradi method have been successfully employed, access to the sac having been obtained by opening the abdomen. Ligature of the aorta has so far been unsuccessful.

**Innominate Aneurysm** may be of the fusiform or of the sacculated variety, and is frequently associated with aneurysm of the aorta. It usually grows upwards and outwards, projecting above the sternum and right clavicle, which may be eroded or displaced by it. Symptoms of pressure on the structures in the neck, similar to those produced by aortic aneurysm, occur. The pulses in the right upper extremity and in the right carotid and its branches are diminished and delayed. Pressure on the right brachial plexus causes shooting pain down the arm and muscular paresis on that side. Vasomotor disturbances and contraction of the pupil on the right side may result from pressure on the sympathetic fibres. Death may take place from rupture, or from pressure on the air-passages.

The available methods of treatment are ligature of the right common carotid and third part of the right subclavian (Wardrop's operation), of which eight successful cases have been recorded. According to Sheen, of Cardiff, the cases most suitable for ligature are those in which the aneurysm is circumscribed and globular. If this is impracticable, needling, electrolysis, or the Moore-Corradi method may be tried.

**Carotid Aneurysms.**—Aneurysm of the *common carotid* is more frequent on the right than on the left side, and is usually situated either at the root of the neck or near the bifurcation of the artery. It is the form of external aneurysm most frequently met with in women. From its position the swelling is liable to press on the vagus, recurrent laryngeal and sympathetic nerves, on the air-passages, and on the œsophagus, giving rise to symptoms referable to such pressure. There may be cerebral symptoms from interference with the vascular supply of the brain.

Aneurysm near the origin of the common carotid has to be

diagnosed from subclavian, innominate, and aortic aneurysm, and from other swellings—solid or fluid—met with in the neck. It is often difficult to determine with precision the trunk from which an aneurysm at the root of the neck originates, and not infrequently more than one vessel shares in the dilatation. A careful consideration of the position in which the swelling first appeared, of the direction in which it has progressed, of its pressure effects, and of the condition of the pulses beyond, may help in distinguishing between aortic, innominate, carotid, and subclavian aneurysms. In some cases skiagraphy is of assistance in recognising the vessel involved.

Tumours of the thyroid, enlarged lymphatic glands, and fatty and sarcomatous tumours can usually be distinguished from aneurysm by the history of the swelling and by careful physical examination. Cystic tumours and abscesses in the neck are sometimes more difficult to differentiate on account of the apparently expansile character of the pulsation transmitted to them. The fact that compression of the vessel does not affect the size and tension of these fluid swellings is useful in distinguishing them.

*Treatment.*—Digital compression of the vessel against the transverse process of the sixth cervical vertebra—the "carotid tubercle"—has been successfully employed in the treatment of aneurysm near the bifurcation. Proximal ligature in the case of high aneurysms, or distal ligature in those situated at the root of the neck, is more certain. The old operation is probably the best method of treatment, especially in aneurysms of traumatic origin.

The *external carotid* and the cervical portion of the *internal carotid* are seldom the primary seat of aneurysm, although they are liable to be implicated by the upward spread of an aneurysm at the bifurcation of the common trunk. In addition to the ordinary signs of aneurysm, the clinical manifestations are chiefly referable to pressure on the pharynx and larynx, and on the hypoglossal nerve. When the hypoglossal nerve is implicated, the corresponding side of the tongue is paralysed. Aneurysm of the internal carotid is of special importance on account of the way in which it bulges into the pharynx in the region of the tonsil, in some cases closely simulating a tonsillar abscess. Cases are on record in which such an aneurysm has been mistaken for an abscess and incised, with disastrous results.

The most satisfactory method of treatment, when it is practicable, is by proximal ligature.

*Aneurysmal varix* may occur in the neck as a result of stabs, cuts, or gun-shot wounds. The communication is usually between the common carotid and the internal jugular vein. The resulting interference with the cerebral circulation causes headache, giddiness, and other brain symptoms, and a persistent loud murmur is usually a source of great annoyance to the patient. If operative treatment is called for, the artery should be ligatured above and below the point of communication.

**Intracranial aneurysm** may involve the internal carotid and its branches, or the basilar artery. These aneurysms appear to be more frequently associated with syphilis and with valvular disease of the heart than are external aneurysms. They are seldom diagnosed from other intracranial tumours during life, as they give rise to no characteristic symptoms, save, in some cases, a loud murmur. They usually prove fatal by rupture and intracranial hæmorrhage. The only available treatment is ligature of the common carotid or of the vertebral artery in the neck.

**Orbital Aneurysm.**—The term pulsating exophthalmos is employed clinically to embrace a number of pathological conditions, including aneurysm, in which the chief symptoms are a marked pulsation in the orbit, and protrusion of the eyeball. There may be, in addition, congestion and œdema of the contents of the orbit and of the eyelids, and a distinct thrill and murmur, which can be controlled by compression of the common carotid in the neck. Varying degrees of ocular paralysis and of interference with vision may also be present.

These symptoms are due, in the majority of cases, to aneurysmal varix of the internal carotid artery and cavernous sinus, which is often traumatic in origin, being produced either by fracture of the base of the skull or by a punctured wound through the orbit. In other cases they are due to aneurysm of the ophthalmic artery, to thrombosis of the cavernous sinus, and, in rare instances, to cirsoid aneurysm.

If compression of the common carotid is found to arrest the pulsation, ligature of this vessel is indicated.

**Subclavian Aneurysm.**—Subclavian aneurysm is usually met with in men who follow occupations involving excessive use of the shoulder—for example, dock-porters and coal-heavers. It is more common on the right side.

The aneurysm usually springs from the third part of the artery, and appears as a tense, rounded, pulsatile swelling just above the clavicle and to the outer side of the sterno-mastoid muscle. It occasionally extends in the direction of the thorax,

where it may become adherent to the pleura. The aneurysm is of slow growth, and occasionally undergoes spontaneous cure. The radial pulse on the same side as the aneurysm is small and delayed. Congestion and œdema of the limb, with pain, numbness, and muscular weakness, may result from pressure on the veins and nerves as they pass under the clavicle; and pressure on the phrenic nerve may induce hiccough.

The conditions most likely to be mistaken for subclavian aneurysm are a soft, rapidly growing sarcoma, and a normal artery raised on a cervical rib. It is to be borne in mind, however, that aneurysm is liable to develop in an artery so displaced by a cervical rib.

On account of the anatomical relations of the artery and the disposition of its branches, surgical treatment is attended with greater difficulty in subclavian than in almost any other form of external aneurysm. Needling or electrolysis should be tried before resorting to operation. The available operative measures are proximal ligature of the innominate, and distal ligature. In some cases it has been found necessary to combine distal ligature with amputation at the shoulder-joint, to prevent the collateral circulation maintaining the flow through the aneurysm. All these operations are serious, and are only undertaken when less dangerous measures fail.

**Axillary Aneurysm.**—Any part of the axillary artery may be the seat of aneurysm. It is usually met with in the right arm of labouring men and sailors, and not infrequently follows an injury in the region of the shoulder. The vessel may be damaged by the head of a dislocated humerus or in attempts to reduce the dislocation, by the fragments of a fractured bone, or by a stab or cut. Sometimes the vein also is injured and an arterio-venous aneurysm established.

Owing to the laxity of the tissues in which the vessel lies, an axillary aneurysm grows more rapidly than a subclavian, and it may soon attain a large size, filling up the axilla, and displacing the clavicle upwards. This renders compression of the third part of the subclavian difficult or impossible. It may extend beneath the clavicle into the neck, or, extending inwards, may form adhesions with the chest wall, and, after eroding the ribs, with the pleura.

The usual symptoms of aneurysm are present, and the pressure effects on the veins and nerves are similar to those produced by an aneurysm of the subclavian. Intra-thoracic complications—pleurisy, pneumonia, hæmoptysis—are not infrequent when the aneurysm forms adhesions to the chest wall

and pleura. Rupture may take place externally, or into the pleura or the shoulder-joint.

Needling or electrolysis should first be tried, and, if these methods are unsuccessful, ligature of the third part of the subclavian may be had recourse to. In cases where the sac is small, the old operation may be preferred.

**Brachial aneurysm** usually occurs at the bend of the elbow, is of traumatic origin, and is best treated by excision of the sac.

*Aneurysmal varix*, which was frequently met with in this situation in the days of the barber-surgeons,—usually as a result of the artery having been accidentally wounded while performing venesection of the median basilic vein,—may be treated, according to the amount of discomfort it causes, by a supporting bandage, or by ligature of the artery above and below the point of communication.

Aneurysms of the vessels of the **forearm and hand** call for no special mention; they are almost invariably traumatic, and are treated by excision of the sac.

**Inguinal Aneurysm** (*Aneurysm of the Iliac and Common Femoral Arteries*).—Aneurysms appearing in the region of Poupart's ligament may have their origin in the external or common iliac arteries or in the common femoral. On account of the tension of the fascia lata, they tend to spread upwards towards the abdomen, and, to a less extent, downwards into the thigh. Sometimes a constriction occurs across the sac at the level of Poupart's ligament.

The pressure exerted on the nerves and veins of the lower extremity causes pain, congestion, and œdema of the limb beyond. Rupture may take place either externally, or into the cellular tissue of the iliac fossa.

These aneurysms have to be diagnosed from pulsating sarcomata growing from the pelvis, and from an abscess, or mass of enlarged lymphatic glands overlying the artery and receiving a transmitted pulsation.

Electrolysis or needling may be considered, but the method of treatment which has met with most success has been ligature of the common or external iliac, reached either by reflecting the peritoneum from off the iliac fossa (extra-peritoneal operation), or by going through the peritoneal cavity (trans-peritoneal operation).

**Gluteal Aneurysm.**—An aneurysm in the buttock may arise from the gluteal or from the sciatic artery, but by the time it forms a salient swelling it is seldom possible to recognise by external examination in which vessel it takes origin. The

special symptoms to which it gives rise are pain down the limb from pressure on the sciatic nerves, and interference with the movements at the hip.

Ligature of the internal iliac by the trans-peritoneal method is the most satisfactory method of treatment. These aneurysms are also suitable for treatment by needling or electrolysis. The old operation is difficult and dangerous, especially when the aneurysm has spread into the pelvis.

**Femoral Aneurysm.**—Aneurysm of the superficial femoral artery is usually traumatic in origin, and is more common in Scarpa's triangle than in Hunter's canal. Any of the methods already described are available for their treatment—the operation of choice being ligature of the external iliac or the old operation.

Aneurysm of the *profunda femoris* is distinguished from aneurysm of the main trunk by the fact that the pulses beyond are, in the former, unaffected, and by the normal artery being felt pulsating over or alongside of the sac.

In *aneurysmal varix*, a not infrequent result of gun-shot wounds and of stabs, the communication with the vein may involve the superficial or deep femoral artery. Should operative interference become necessary as a result of progressive increase of the size of the tumour, or progressive distension of the veins of the limb as a whole, an attempt should be made to separate the vessels concerned and to close the opening in each by a fine suture. If this is impracticable, the artery is tied above and below the communication. Gangrene of the limb may supervene after ligature, and we have observed a case in which the gangrene extended as high as the junction of the middle and lower thirds of the thigh.

**Popliteal Aneurysm.** — Popliteal aneurysm is the most common surgical aneurysm, and the condition is not unfrequently bilateral. It is generally due to disease in the artery, although repeated slight strains, which are so liable to occur at the knee, may play an important part in determining its formation. In former times it was very common in post-boys from the repeated flexion and extension of the knee in riding.

The aneurysm is usually of the sacculated variety, and may spring from the front or from the back of the vessel. According to the direction of its growth it exerts pressure on the bones and ligaments of the joint, and it has been known to open into the articulation. The pain, stiffness, and effusion into the joint which accompany these changes often lead to an erroneous diagnosis of joint disease. It may press upon the popliteal

vein, causing congestion and œdema of the leg, and leading to gangrene. Pressure on the popliteal nerves gives rise to severe pain, muscular cramp, and weakness of the leg.

The differential diagnosis is to be made from abscess, bursal cyst, enlarged glands, and sarcoma.

The choice of operation lies between ligature of the femoral artery in Hunter's canal, and the old operation. The success which attends the Hunterian operation is evidenced by the fact that Syme performed it thirty-seven times without a single failure. If it fails, the old operation should be considered, but it is a much more serious operation, and one which is more liable to be followed by gangrene of the limb. Experience shows that ligature of the vein, or even the removal of a portion of it, is not necessarily followed by gangrene if the wound remains aseptic. The onset of gangrene from any cause is an indication for immediate amputation.

*Aneurysmal varix* is sometimes met with in the region of the popliteal space. It is characterised by the usual symptoms, and is treated by palliative measures, or by ligature of the artery above and below the point of communication.

*Aneurysm in the* **leg and foot** is rare. It is almost always traumatic, and is treated by excision of the sac.

# CHAPTER XV.

## THE LYMPHATICS.

Anatomy and physiology—Injuries of Lymphatic Vessels: *Wounds of thoracic duct*—Diseases of Lymphatic Vessels—Lymphangitis: *Varieties*—Lymphangiectasis—Filarial disease—Lymphangioma—Diseases of Lymphatic Glands—Lymphadenitis: *Septic; Tuberculous; Syphilitic*—Lymphadenoma—Leucocythæmia—Tumours.

Lymph is essentially blood plasma which has filtered through the walls of capillaries. After bathing and nourishing the tissues, it is collected by lymphatic vessels which return it to the blood-stream by way of the thoracic duct. These lymphatic vessels take origin in the lymphatic spaces of the tissues and in the walls of serous cavities, and they usually run alongside blood-vessels—*perivascular lymphatics*. They have a structure similar to that of veins, but are more abundantly provided with valves. Along the course of the lymphatic trunks are the *lymphatic glands*. These are composed of a reticulated connective tissue, the spaces of which are packed with leucocytes; and they possess a definite capsule. The lymph in passing through a gland follows a tortuous course, whereby it is brought into intimate contact with the leucocytes in the gland. The action of the leucocytes on the lymph as it passes through the gland is of great physiological importance. The glands not only arrest inert substances, such as blood pigment circulating in the lymph, but also living elements, such as cancer cells or bacteria. In bacterial infections there is always a struggle between the organisms brought to the glands and the leucocytes, so that the glands may be looked upon as an important line of defence, preventing or retarding the passage of bacteria and their products into the general circulation. The infective agent therefore, in order to reach the blood-stream, must usually overcome the resistance of a whole chain of glands. This attempt to repel organismal attacks, however, may fail, and the common diseases of lymphatic glands are thus brought about.

Lymphatic glands are, for the most part, arranged in groups or chains, such as those in the axilla, neck and groin. They vary in number and size in different individuals in any given situation, and fresh glands may be formed on comparatively slight stimulus, and disappear when the stimulus is withdrawn. The best-known example of this is the increase in the number of glands in the axilla which takes place during lactation. When this function terminates many of the glands become involuted and are transformed into fat. In the event of a sub-

sequent lactation or of a cancer appearing in the breast later in life, the glands are again developed. Glands which have been removed by operation are readily re-formed, and after some time the newly formed glands are not distinguishable from the original ones.

*Anatomical Distribution of Glands.*—The more important groups of glands, and the areas which they drain, in the head and neck and in the upper and lower extremities, are as follows :—

**Head and Neck.**—*The parotid or pre-auricular glands* lie beneath the parotid fascia in front of the ear, and some are partly embedded in the substance of the parotid gland ; they drain the parts about the temple, cheek, eyelids, and auricle. *The occipital gland*, situated over the origin of the trapezius from the superior curved line, drains the top and back of the head. *The mastoid or posterior auricular glands* lie over the mastoid process, and drain the side of the head and auricle. These three groups pour their lymph into the cervical glands. *The submaxillary*—two to six in number—lie along the lower border of the jaw from the symphysis to the angle, the posterior ones being closely connected with the submaxillary salivary gland. They receive lymph from the face, lips, floor of the mouth, gums, teeth, anterior part of tongue, and the alæ nasi, and from the pre-auricular glands. The lymph passes from them into the deeper cervical glands. *The submental gland* lies in the middle line between the anterior bellies of the digastric muscles, and receives lymph from the lips. *The supra-hyoid* lies a little farther back, immediately above the hyoid bone, and receives lymph from the tongue. *The external jugular glands* lie along the external jugular vein. They are not always present. They receive lymph from the occipital and mastoid glands and from the auricle. *The sterno-mastoid glands*—glandulæ concatinatæ—form a chain along the posterior edge of the sterno-mastoid muscle, some of them lying beneath the muscle. They are commonly enlarged in constitutional syphilis. *The internal jugular glands*, commonly called the deep cervical,—from six to twenty in number,—form a continuous chain along the internal jugular vein, beneath the sterno-mastoid muscle. They drain the various groups of glands which lie nearer the surface, also the interior of the skull, larynx, trachea, thyroid, and lower part of the pharynx. They pour their lymph into the main lymphatic trunks at the root of the neck. Belonging to this group is one large gland which lies behind the posterior belly of the digastric, and rests in the angle between the internal jugular and common facial veins. It is commonly enlarged in affections of the tonsil and posterior part of the tongue. Belonging to the same group are three or four glands which lie entirely under cover of the upper end of the sterno-mastoid muscle, and surround the spinal accessory nerve before it perforates the muscle. *The supra-clavicular glands* lie in the posterior triangle, above the clavicle. They receive lymph from the lowest cervical glands, from the upper part of the chest wall, and from the highest axillary glands. They are frequently infected in cancer of the breast ; those on the left side also in cancer of the stomach. *The retro-pharyngeal glands* lie on each side of the middle line upon the rectus capitis anticus major muscle and in front of the prevertebral layer of the cervical fascia. They receive part of the lymph from the posterior wall of the pharynx, the interior of the nose and its accessory cavities, the Eustachian tube, and the tympanum. When they are infected with pus organisms or with tubercle bacilli they may lead to the formation of one form of retro-pharyngeal abscess.

**Upper Extremity.**—*The epi-trochlear and ante-cubital glands* vary in

number and in situation. That most commonly present lies about an inch and a half above the internal condyle. Other and smaller glands may lie along the internal bicipital sulcus or at the bend of the elbow. They drain the ulnar side of the hand and forearm, and pour their lymph into the axillary group. The epi-trochlear gland is sometimes enlarged in syphilis. *The axillary glands* are arranged in three groups. A central group lie embedded in the axillary fascia, and are often related to an opening in it. A subscapular group lie along the line of the subscapular vessels. Pectoral groups lie behind the pectoralis minor, along the inner side of the axillary vein, and between the two pectoral muscles. The axillary glands receive lymph from the arm, mamma, and side of the chest, and pass it on into the lowest cervical glands and the main lymphatic trunk.

**Lower Extremity.**—*The popliteal glands* include one superficial gland at the termination of the short saphenous vein, and several deeper ones in relation to the popliteal vessels. They receive lymph from the toes and foot, and transmit it to the inguinal glands. *The femoral glands* lie vertically along the upper part of the internal saphenous vein, and receive lymph from the leg and foot. From them the lymph passes to the deep inguinal and external iliac glands. *The superficial inguinal glands* lie along Poupart's ligament, and receive lymph from the external genitals, anus, perineum, buttock, and anterior abdominal wall. The lymph passes on to the deep inguinal and external iliac glands. *The deep inguinal glands* lie on the inner side of the femoral vein, and sometimes within the crural canal. They receive lymph from the deep lymphatics of the lower limb, and some of the efferent vessels from the femoral and superficial inguinal glands. The lymph then passes on through the crural canal to the external iliac glands.

The glands of the thorax and abdomen will be considered with the surgery of these regions.

## Injuries of Lymphatic Vessels.

Lymphatic vessels are divided in all wounds, and the lymph which escapes from them is added to any discharge which may be present. In the case of larger trunks the lymph may escape in considerable quantity as a colourless, watery fluid—*lymphorrhagia;* and the opening through which it escapes is known as a *lymphatic fistula.* This has been observed chiefly after extensive operations for the removal of malignant glands in the groin, and in such cases provision must be made by drainage tubes for the escape of lymph, which may escape in such abundance as to soak through large dressings and delay the healing of the wound. Ultimately new lymph channels are formed, so that at the end of from four to six weeks the discharge of lymph ceases and the wound granulates up and heals.

When the lymphatic return from a limb has been seriously interfered with,—as, for example, when the axillary contents have been completely cleared out in operating for cancer of the

breast,—a condition of *lymphatic œdema* may result, the arm becoming swollen, tight, and heavy.

**Wounds of the Thoracic Duct.**—The thoracic duct usually opens at the angle formed by the junction of the left internal jugular and subclavian veins, but it may open into either of these vessels by one, or by several channels, or the duct may be double throughout its course. There is a smaller duct on the right side—the right thoracic duct. The position of the duct may be altered by the presence of a tumour, or by a mass of enlarged glands. In dissections at the root of the neck the duct may be accidentally wounded, and jets of milky fluid—chyle—may at once escape from it. The jets are rhythmical and coincide with expiration. The injury is, however, seldom recognised at the time of operation; more commonly the dressings are found to be soaked with chyle—*chylorrhœa*. If the wound involves the only existing main duct and all the chyle escapes, the patient suffers from intense thirst, emaciation, and weakness, and may die of inanition; but if, as is usually the case, only one of several collateral channels is implicated, the loss of chyle may be of little moment as the discharge usually ceases spontaneously. If the skin wound is sutured and heals, a fluctuating swelling may form beneath the scar, and in course of time gradually disappear.

In treating an accidental wound of the duct, it is rarely possible to close it with sutures, it should therefore be seized with forceps and ligatured as if it were a bleeding artery. The tissues are then stitched over it and the skin wound accurately closed, so as to obtain healing by first intention. Firm pressure should be applied by dressings and a bandage. Even if the main duct is obliterated, a collateral circulation is usually established. The patient should be fed on a diet rich in fat and egg albumin to promote a copious flow of chyle, and so encourage the establishment of a collateral circulation. A wound of the main lymphatic duct on the right side is of less importance.

*Subcutaneous rupture of the thoracic duct* may result from a crush of the thorax. The chyle escapes and may accumulate in the cellular tissue of the posterior mediastinum and behind the peritoneum, in the pleural cavity (*chylo-thorax*), or in the peritoneal cavity (*chylous ascites*). There are physical signs of fluid in one or other of these situations, but the nature of the lesion is only recognised when chyle is withdrawn by the exploring needle.

## Diseases of Lymphatic Vessels.

**Lymphangitis.**—Inflammation of peripheral lymphatic vessels usually results from the entrance of pyogenic bacteria or their products from some primary source of infection in the skin. This may be a septic wound or a purulent blister, and the streptococcus pyogenes is the organism most frequently present. Septic lymphangitis is commonly met with in those who, from the nature of their occupation, handle infective material. A *gonococcal lymphangitis* has been observed in those suffering from gonorrhœa.

The inflammation affects chiefly the walls of the vessels and is attended with clotting of the lymph. There is also some degree of inflammation of the surrounding cellular tissue —*peri-lymphangitis.* One or more abscesses may form along the course of the affected vessels, or a spreading cellulitis may supervene.

The *clinical features* resemble those of other acute pyogenic infections, and there are wavy red lines running from the source of infection towards the nearest lymphatic glands. These correspond to the inflamed vessels, and are the seat of burning pain and tenderness. The associated glands are enlarged and painful. In severe cases the symptoms may merge into those of septicæmia. When the deep lymphatics are involved, the superficial red lines are absent and the limb is œdematous.

In cases of extensive lymphangitis, especially where there are repeated attacks, the vessels may be obliterated by the formation of new connective tissue and a persistent solid œdema result, culminating in one of the forms of elephantiasis.

*Treatment.*—The primary source of infection is dealt with on the usual lines. The patient is confined to bed, and the affected limb is elevated on a pillow. The area in relation to the inflamed lymphatics is enveloped in a fomentation of weak carbolic—1 in 60—or of lead and opium. If suppuration occurs, the pus must be let out. If the infection is due to the streptococcus pyogenes, and if the toxic symptoms are severe, the antistreptococcic serum should be injected. When the inflammation has subsided, the limb is massaged and evenly bandaged to prevent œdema.

*Tuberculous Lymphangitis.*—Although lymphatic vessels play such an important rôle in the spread of tuberculosis, the clinical recognition of tuberculous disease of lymphatic vessels is exceptional. It is met with chiefly in relation to tuberculous lesions of the skin of the extremities, such as lupus, inoculation

tubercle, and sinuses resulting from dactylitis. The infection spreads upwards along the superficial lymphatics, which become nodularly thickened, while at one or more points larger, perilymphangitic nodules, which tend to break down into abscesses and ulcers, may form. When the disease is widely distributed throughout the lymphatics, the limb may become swollen and hard—a condition illustrated by lupus elephantiasis.

Treatment must be directed both to the original source of infection and to the diseased lymphatics.

*Syphilitic lymphangitis* is best observed in the vessels of the dorsum of the penis, where these may be felt as indurated cords in cases of primary syphilis.

In addition to acting as channels for the conveyance of bacterial infection, *lymphatic vessels frequently convey the cells of malignant tumours*, and especially cancer, from the seat of the primary disease to the nearest lymphatic glands, and they may themselves become the seat of cancerous growth forming nodular cords (Fig. 86). This fact is of great importance in relation to the eradication of cancer by operative measures.

**Lymphangiectasis** is a dilated or varicose condition of lymphatic vessels. It is sometimes met with as a congenital affection in the tongue and lips, and it may be acquired as the result of any condition which is attended with extensive obliteration or blocking of the main lymphatic trunks. The most important type of lymphangiectasis is that resulting from the presence of the *filaria sanguinis hominis* in the vessels, and which is observed chiefly in the groin, spermatic cord, and scrotum.

*Filarial disease in the lymphatics of the groin* appears as a soft, doughy swelling, varying in size from a walnut to a cocoa-nut; it may partly disappear on pressure and on lying down.

There may be no other symptoms, or the patient may give a history of feverish attacks during which the swelling becomes painful and tender. These attacks may show a remarkable periodicity, and each may be followed by an increase in the size of the swelling. The swelling may extend along the inguinal canal into the abdomen, or down the spermatic cord into the scrotum. On dissection, the swelling is found to be made up of dilated, tortuous, and thickened lymphatic vessels in which the parent worm is sometimes found, and of greatly enlarged lymphatic glands which have become converted into a tough, spongy tissue, the spaces of which are filled with lymph. The fluid in the dilated vessels is either clear or turbid, in

the latter case resembling chyle. The affection is frequently bilateral, and may be associated with lymph scrotum, with elephantiasis, and with chyluria.

The *diagnosis* is to be made from other swellings in the groin, such as hernia, lipoma, or cystic pouching of the saphena vein. It is aided by obtaining the history that the patient has lived in the tropics, and by finding the embryo of the filariæ in the blood.

*Treatment.*—This is influenced by whether the disease is limited to the groin or scrotum, or whether it is generalised throughout the body. Opinion is divided as to the advantages of excision, even in the localised disease. While on the one hand it may bring about a permanent cure, especially if the adult worms are found in the dilated lymphatics which are removed, on the other it may result in the formation of lymphatic sinuses and only afford temporary relief. When the disease is generalised, operation is contra-indicated, and all that can be done is to apply a pad and elastic bandage.



FIG. 69.—Congenital Cystic Tumour or Hygroma of Axilla.

**Lymphangioma** bears the same relation to lymph-vessels as angioma bears to blood-vessels. It consists of cavities and channels filled with lymph, and freely communicating with one another. Their walls are composed of fibro-areolar tissue, lined by endothelium, and sometimes strengthened by non-striped muscle. The cavities result either from the new formation of lymphatic spaces and vessels, or from the dilatation of those which already exist. When the tumour is made up of a meshwork of caverns and channels, it is called a *cavernous lymphangioma*; when it is composed of one or more separate cysts,

it is called a *cystic lymphangioma* or *lymphatic cyst*. It is probable that the cysts are derived from the caverns by the breaking down and absorption of the intervening septa, and transition forms between the cavernous and cystic varieties are frequently met with. They are probably all of congenital origin, and they usually appear at or shortly after birth. They are rarely provided with a definite capsule, and they frequently send prolongations of their substance between and into muscles and other structures in their vicinity.

*The cavernous lymphangioma* appears as an ill-defined soft swelling presenting many of the characters of the subcutaneous angioma, but it is not capable of being emptied by pressure, the skin over it is normal, and if the tumour is punctured with an exploring needle it will yield lymph instead of blood. It also resembles a congenital lipoma, especially one growing from the periosteum, and the differential diagnosis is rarely completed until the swelling is punctured or explored by operation.

*The cystic lymphangioma* presents all the features of a cystic tumour. It is most often met with in the neck, springing from beneath the deep fascia, and projecting either in front of or behind the sterno-mastoid. It may attain a very large size, in which case the cyst wall may be so thin as to be translucent. It is also known under the names of *hydrocele of the neck* and *congenital cystic hygroma*. When it occurs on the floor of the mouth, it constitutes one form of ranula. It is also met with in the axilla (Fig. 69). These swellings are distinguished from dermoids by having thinner walls, and in being less definitely circumscribed. A remarkable feature is their liability to attacks of inflammation, which are usually followed by shrinkage and disappearance of the swelling. Sometimes the cystic variety is converted into an abscess—another, although less desirable method of cure. Those situated in the neck are most liable to become inflamed, probably because of pyogenic infection being brought to them by lymphatic vessels from the scalp, ear, or throat. The frequency of spontaneous cure explains the rarity of such cysts after puberty.

*Treatment.*—The cavernous lymphangioma may be left alone, or may be subjected to electrolysis, ignipuncture, or excision. Complete excision is rarely possible, because of the want of definition and encapsulation. The cystic form may be injected with iodine, or tapped and drained, or it may be excised.

## Diseases of Lymphatic Glands.

**Lymphadenitis.**—Inflammation of lymphatic glands results from the absorption of an irritant, usually bacterial or toxic, brought to the glands by the afferent lymphatics. These vessels may share in the inflammation and be the seat of lymphangitis, or they may show no evidence of the passage of the irritant. It is exceptional for the irritant to be carried to the gland in the blood-stream.

A strain or other form of trauma is sometimes blamed for the onset of lymphadenitis, especially in the glands of the groin (bubo), but it is usually possible to discover some source of pyogenic infection which is responsible for the mischief, or to obtain a history of some antecedent affection such as gonorrhœa. It is possible that gonococci may lie latent in the inguinal glands for long periods, and only give rise to lymphadenitis if the glands be subsequently subjected to injury. The glands most frequently the seat of inflammation are those in the neck, axilla, and groin.

The characters of the inflammation vary with the nature of the irritant. Sometimes it is mild and evanescent, as in the glandular enlargement in the neck which attends tonsillitis and certain other forms of sore throat. Sometimes it is more persistent, as in the enlargement which may be associated with adenoids, hypertrophied tonsils, carious teeth, eczema of the scalp, and otorrhœa; and it is probable that this indolent enlargement predisposes to tuberculous infection. A similar enlargement is met with in the axilla in cases of chronic interstitial mastitis, and in the groin as a result of chronic irritation about the external genitals.

Sometimes the inflammation is of a more acute character, and the tendency is towards the formation of an abscess. This is illustrated in the axillary glands inflamed as a result of infected wounds of the fingers, in the femoral glands in infected wounds or purulent blisters on the foot, in the inguinal glands in gonorrhœa and soft chancre, and in the cervical glands in the severer forms of sore throat associated with diphtheria and scarlet fever. The most acute glandular suppurations result from infection with streptococci.

Superficial glands, when inflamed and suppurating, become enlarged, tender, fixed, and matted to one another. In the glands of the groin the suppurative process is often remarkably sluggish. Purulent foci form in the interior of the individual glands, and some time may elapse before the pus erupts through their respective capsules. In the deeply placed cervical glands,

especially in cases of streptococcal throat infections, the suppuration rapidly involves the surrounding cellular tissue, and the clinical features are those of an acute cellulitis and deeply seated abscess. When this is incised the necrosed glands may be found lying in the pus, and on bacteriological examination are found to be swarming with streptococci. In suppuration of the axillary glands, the abscess may be quite superficial, or it may be deeply placed beneath the strong fascia and pectoral muscles, according to the group of glands involved. Those in the groin resulting from gonorrhœa and soft chancre are described under these heads.

The *diagnosis* of septic lymphadenitis is usually easy. The indolent enlargements are not always to be distinguished, however, from commencing tuberculous disease, except by the fact that they usually disappear on removing the peripheral source of irritation.

*Treatment.*—The original source of infection having been removed, the treatment applicable to the glands varies according to the nature and degree of the inflammation. Rest and soothing applications are indicated in the early stage of inflammation. Glycerine and belladonna, or the oleate of mercury ointment, is useful in indolent enlargements ; lead and opium or carbolic fomentations in the more acute forms of lymphadenitis. If suppuration has taken place and is confined to the glands, as in the groin, each focus should be attacked with the knife, spoon, and pure carbolic acid, or the whole chain of glands may be excised. If, on the other hand, there is a large peri-glandular abscess, as is often the case in the neck and axilla, this should be opened—preferably by Hilton's method. The opening should be enlarged to admit the finger and allow of the removal of any glands which have not completely broken down, and which probably contain other foci of suppuration. If the suppurative bubo associated with soft chancre is simply incised, the tendency is towards the formation of an inflamed ulcer resembling the original sore. It is better, therefore, to excise the gland along with the infiltrated and undermined skin, unless there is already a considerable abscess, in which case it should be incised, scraped, painted with pure carbolic acid, and packed with iodoform worsted.

**Tuberculous Disease of Glands.**—This is a disease of great frequency and importance. The tubercle bacilli usually gain access to the glands through the afferent lymphatic vessels, which convey them from some lesion of the mucous surface within the area which they drain. It is possible, however, that the

organisms are sometimes carried to the glands by the blood-stream. The tuberculous infection may supervene in glands which are already enlarged as a result of chronic septic irritation, or in glands which are healthy. While any of the glands in the body may be affected, the disease is most often met with in the groups of cervical glands which derive their lymph from the mouth, nose, throat, ear, and scalp.

*The appearance of the glands on section* varies with the stage of the disease. In the earliest stages the gland is enlarged, it may be to many times its natural size, is normal in colour, and firm in consistence without any infiltration or adhesion of the capsule, so that it is easily shelled out from its surroundings. On microscopical examination, however, there is evidence of tuberculous infection in the shape of bacilli and of characteristic giant and epithelioid cells. At a later stage the gland tissue is studded with minute yellow caseating foci which tend to enlarge and in time to become confluent, so that the whole gland is ultimately converted into a caseous mass. This caseous material is surrounded by the thickened capsule which, as a result of peri-adenitis, tends to become adherent to and fused with surrounding structures, and particularly with layers of fascia and with the walls of veins. The caseated tissue may become calcified, but more frequently it liquefies and breaks down into tuberculous pus.

*Disease in the cervical glands* is a common accompaniment or sequel of adenoids, enlarged tonsils, carious teeth, pharyngitis, middle-ear disease, conjunctivitis, and suppurative lesions of the scalp, such as impetigo. These lesions afford the bacilli a chance of entry into the lymphatics, in which they are carried to the glands of the neck, where they give rise to tuberculous disease.

In the neck the enlargement may affect only one gland, usually below the angle of the jaw, and remain confined to it. The enlarged gland varies in size from a hazel nut to a walnut, is ovoid, firm, and painless. More commonly the disease affects several glands, and the glands on one and sometimes on both sides of the neck may be involved. When the disease commences in the pre-auricular or submaxillary glands, it tends to spread to those along the carotid sheath. When the posterior auricular and occipital glands are first involved, the spread is to those along the posterior border of the sterno-mastoid. In many cases all the various chains in front of, beneath, and behind this muscle are involved, the enlarged glands extending from the mastoid to the clavicle. When several glands are affected, they are at first discrete and movable,

and may even vary in size from time to time, but with the addition of peri-adenitis they become fixed and matted together, forming large lobulated or nodular masses. They become adherent not only to one another, but also to the structures in their vicinity—and notably to the internal jugular vein—a point of considerable importance in regard to their removal by operation.

At any stage the progress of the disease may be arrested and the glands may remain for long periods without further change. It is possible that the tuberculous tissue in the interior of the glands may undergo cicatrisation and so effect a cure. More commonly it terminates in suppuration, and the result is an abscess, which is usually of the cold variety, but may partake of the more active features of the pyogenic type. The transition from the solid to the liquefied stage of the disease is attended with pain and tenderness in the gland, which at the same time becomes fixed—especially to the skin—and more globular. Finally fluctuation is readily elicited.

If left to itself the softened tubercle erupts through the capsule of the gland and infects the cellular tissue. The cervical fascia is perforated, and a cold abscess, often much larger than the gland from which it took origin, forms between the fascia and the overlying skin. The further stages—reddening, undermining of skin and external rupture, with the formation of ulcers and sinuses—have been described with tuberculous abscess (p. 148). The ulcers and sinuses may persist indefinitely, or may heal up for a time and then break out afresh; and sometimes the skin becomes the seat of tuberculous disease, which may spread like lupus, especially in the submaxillary region, until it eventually extends from ear to ear. Healing may finally take place after all the caseous tubercle has been extruded, but the resulting scars are extremely unsightly, being puckered or bridled, or even highly coloured and hypertrophied like keloid

While the disease is most common in childhood and youth, it may be met with even in advanced life; and although commonly associated with depraved health and unhealthy surroundings, it may affect those who are apparently robust and in affluent circumstances.

*Diagnosis.*—Tuberculous disease is differentiated from the glandular enlargement which results from septic irritation by its persistence after all sources of irritation have been removed. It is rarely possible to differentiate tuberculous disease from lymphadenoma and from lympho-sarcoma at a stage when a positive diagnosis would be of real value, unless a gland is excised

and submitted to microscopical examination. The subsequent progress usually clears up the diagnosis. Signs of liquefaction and suppuration in the glands indicate the tuberculous nature of the disease. Other forms of sarcoma, and the enlargement of an accessory thyroid, are less likely to be confused with glandular tumours.

Glandular enlargement from secondary cancer may closely simulate tuberculosis—especially when the cancerous glands have undergone liquefaction—but is to be differentiated by its association with cancer in the mouth, throat, or other adjacent part, and by the early induration and fixation of the glands affected.

Cold abscess resulting from tuberculous glands is to be distinguished from that due to disease in the cervical spine, as well as from congenital and other cystic swellings in the neck.

*Prognosis.*—Next to lupus, glandular disease is of all tuberculous lesions the least dangerous to life. Nevertheless, a large proportion of those who suffer from it in childhood or youth afterwards suffer from tuberculous disease in bones and joints, and in internal organs, especially the lungs. So far as the disease in the glands is concerned, the prognosis is materially influenced by the social circumstances of the patient and by the treatment adopted.

*Treatment.*—The morbid conditions vary so widely in different cases that no one line of treatment can be expected to suffice in all: every case must be considered and treated on its own merits. The extent of the disease, its duration and progress, the previous treatment and its results, and the general health and surroundings of the patient must all be taken into account.

*When seen in the early stages*, before there are any signs of liquefaction in the gland, the disease may be arrested by removing any peripheral irritation in the mouth or throat, and improving the general health by fresh air, good food, and cod-liver oil. Arsenic is useful in diminishing the peri-adenitis. External applications such as iodine or mercurial ointment are of doubtful value. A wire or felt splint may be employed to restrain the movements of the head and neck, but in most cases it is sufficient to apply cotton wool and a bandage. It is at this stage that *exposure to the X-rays* is most likely to be of value. Two or three applications per week for two or three months are usually necessary to give the method a fair trial.

*When seen at a later stage*, when, in spite of the above treatment, the glandular enlargement persists, and especially if it is on the increase, and there is involvement of fresh glands, removal by operation should be recommended.

When there are *signs of liquefaction* in the gland, or of a *cold abscess* in the tissues around, operative interference should be had recourse to without delay, in order to hasten the reparative process and to diminish the amount of disfigurement.

*The operative treatment* varies with the condition of the glands. A mass of enlarged glands is excised along with the deep fascia by a careful process of dissection; if liquefaction has taken place, the condition is dealt with like a cold abscess. Where there is a combination of enlarged glands and abscesses, the latter are dealt with first, and the glands are excised either at the same operation or after an interval. Where there are sinuses these are excised or scraped, and all diseased skin is cut away, in addition to getting rid of the diseased glands.

*The excision of tuberculous glands* is often an extensive and difficult operation, because of the number and deep situation of the glands to be removed, and because of the adhesions to surrounding structures. The skin incision must be sufficiently extensive to give access to the whole of the affected area, and to avoid disfigurement should, whenever possible, be made in the line of the natural creases of the skin. Where glands are to be removed from both anterior and posterior triangles, the best access is obtained by a Z-shaped incision, the upper limb running parallel with the lower jaw, the vertical limb along the sterno-mastoid, and the lower limb parallel with the clavicle. In exposing the glands the common facial and other venous trunks may require to be clamped and ligatured. Care must be taken not to injure the important nerves, particularly the spinal accessory, the vagus, and the phrenic. The inframaxillary branches of the facial, the hypoglossal and its descending branches, and the motor branches of the deep cervical plexus are liable to be injured, and should, if possible, be conserved. In the removal of matted glands beneath the sterno-mastoid, it may be necessary to cut this muscle across and to reflect the divided ends upwards and downwards; if the muscle itself is infiltrated with tubercle, the affected portion is removed along with the glands. When the glandular mass is closely adherent to the internal jugular vein, the operation is rendered easier by ligaturing the vein at the root of the neck and removing it from below upwards along with the glands (Watson-Cheyne). When the glands are extensively affected on both sides of the neck, it may be advisable to allow an interval to elapse rather than to operate on both sides at one sitting.

*The scraping of softened glands and peri-glandular abscesses*, although a useful and often a very necessary operation, is not

certain of permanently curing the patient, because diseased tissue is apt to be left behind; and it is not altogether free from the risk of being followed by dissemination of the tuberculous infection, and general tuberculosis. In opening a glandular abscess the incision should be large enough to allow of its interior being inspected; it is then possible to introduce the spoon into the various pockets, and especially through the opening in the deep fascia leading down to the gland from which the abscess originated. Success depends on the thoroughness with which all the tuberculous tissue is removed. The wall of the resulting cavity is painted over with tincture of iodine, and the wound is packed with iodoform worsted. The packing is renewed at intervals until the wound heals. The healing of such cavities and sinuses is often greatly favoured by repeated applications of the X-rays.



FIG. 70.—Hodgkin's Disease in a boy aged 5.

(From Byrom Bramwell's *Atlas of Clinical Medicine.*)

Tuberculous disease *in the axillary glands* may be met with as a result of extension from the glands in the neck, from tuberculous disease of the mamma, ribs, or sternum, or more rarely from tuberculous disease in the fingers or arm. Sometimes it is impossible to discover the source of infection, in which case we can only assume that it has taken place through the blood-stream. The glands frequently attain a large size, and are usually freely movable. The treatment consists in removing them by an operation similar to that employed in clearing out the contents of the axilla in cases of cancer of the breast.

In the *glands of the groin* tuberculous disease is comparatively rare. We have chiefly observed it in the femoral glands as a result of inoculation tubercle on the toes or sole of the foot. The affected glands tend to break down and suppurate, and after

destroying the overlying skin give rise to fungating tuberculous ulcers.

The treatment consists in excising the glands and the affected skin. The dissection is often attended with troublesome hæmorrhage from the numerous veins which converge towards the common femoral trunk.

Tuberculous affections of the *mesenteric* and *bronchial glands* will be referred to later.

**Syphilitic Disease of Glands.**—Enlargement of lymphatic glands is a prominent feature in acquired syphilis, especially in the form of the indolent or bullet-bubo, which so commonly accompanies the primary lesion, and the general enlargement of glands which occurs throughout the body in secondary syphilis. Gummatous disease in glands is extremely rare, although it is slightly more common in the inherited than in the acquired form of the disease. The affected gland rapidly enlarges to the size of a walnut or an apple, and may then persist for a long period without further change; if it breaks down, the overlying skin is destroyed and the caseated gummatous material exposed. The condition readily yields to antisyphilitic treatment.

**Lymphadenoma.**—*Hodgkin's Disease* (Pseudoleucæmia of German authors).—This is a disease which is usually met with in children between 5 and 15 years, and in males below middle age. It begins as a slow, painless enlargement of some particular group of glands, most commonly those in the cervical region. The glands are usually larger than in tuberculosis, and they remain longer discrete and movable and without pain or discomfort. In time the glandular masses may form enormous projecting tumours, the swelling being added to by œdema of the overlying cellular tissue and skin (Fig. 70).

The enlargement spreads along the cervical chain of glands to those above the clavicle, to those in the axilla, and to those of the opposite side. Later the glands in the groin can be seen and felt to be enlarged. It is probable that the infection has spread from the glands in the neck along the mediastinal, bronchial, retro-peritoneal, and mesenteric glands, and has branched off from thence to the iliac and inguinal groups.

When the disease has thus become generalised, the patient's health suffers and he becomes feverish and anæmic. The blood presents the characters met with in secondary anæmia, and although polynuclear leucocytosis may be observed at any stage, it is not an essential feature of the disease but an evidence of secondary infection. The spleen, liver, testes, and mammæ may be enlarged. The glandular swellings may press on important

structures, such as the trachea, œsophagus, or great veins, and give rise to symptoms referable to such pressure. The disease usually terminates fatally within one or two years of its commencement. The structural changes in the lymphatic glands are not characteristic of any specific infection. The glands are hypertrophied and the lymph spaces crowded with leucocytes, and in the later stages the fibrous framework of the gland becomes thickened. The origin of the disease is as yet unknown, but analogy would suggest that it is due to infection with a slowly growing micro-organism.

*Diagnosis.* — The true relationships of lymphadenoma to lympho-sarcoma and to leucocythæmia are as yet imperfectly established, so that it is impossible to state definitely the points upon which a differential diagnosis may be founded. True leucocythæmia is to be recognised by the characteristic alterations in the blood. Lympho-sarcoma commences in one particular gland and runs a clinical course similar to that of other forms of sarcoma. The diagnosis from tuberculosis at an early stage can only be made by removing one of the glands and submitting it to microscopical examination.

*Treatment.*—In genuine cases of lymphadenoma treatment is of little avail. Arsenic is given in full doses either by the mouth or by subcutaneous injection. The excision of glands, although sometimes beneficial, seldom arrests the progress of the disease. The ease and rapidity with which large masses of glands may be shelled out is in remarkable contrast to what is observed in tuberculous disease. Surgical interference may give relief when important structures are being pressed upon—tracheotomy, for example, may be required where life is threatened by asphyxia.

**Leucocythæmia.**—This is a disease of the blood and of the blood-forming organs in which there is a great increase in the number, and an alteration of the character of the leucocytes present in the blood. It may simulate lymphadenoma, because, in certain forms of the disease, the lymphatic glands, especially those in the neck, axilla, and groin, are greatly enlarged, and there is a gradual failure of health terminating in death.

## Tumours of Lymphatic Glands.

**Primary Tumours.**—It is very doubtful if there exists an *innocent lymphoma* or simple hypertrophy of glands apart from the diseased conditions already described.

The malignant lymphoma or *lympho-sarcoma*, which cannot always be differentiated from lymphadenoma, may be regarded

as a sarcoma starting in lymphatic glands. It appears in the neck, axilla, or mediastinum, as a rapidly growing tumour consisting of one enlarged gland with numerous satellites. As the tumour increases in size, the sarcomatous tissue erupts through the capsule of the glands, and infiltrates the surrounding tissues, whereby it becomes fixed to these and to the skin.

The only treatment is early excision, but the results are most disappointing.

**Secondary Tumours.**—Next to tuberculosis, *secondary cancer* is the most common and most important disease of lymphatic glands. In the neck it is met with in association with epithelioma of the lip, tongue, or throat. The glands form tumours of variable size, and are often larger than the primary growth, the characters of which they reproduce. The glands are at first hard and movable, but soon become fixed, and in time they soften, liquefy, and burst through the skin, forming foul, fungating ulcers. A similar affection is met with in the groin from epithelioma of the penis, scrotum, or vulva. In cancer of the breast, the affection of the axillary glands is an important complication.

In *pigmented* or *melanotic cancers* of the skin, the glands are early infected and increase rapidly, so that when the primary growth is still of small size—as, for example, on the sole of the foot—the femoral glands may already constitute large pigmented tumours.

The implication of the glands in other sites and varieties of cancer will be considered with regional surgery.

*Secondary sarcoma* is seldom met with in glands except when the primary growth is situated in the tonsil, thyroid, or testicle.

# CHAPTER XVI.

## THE NERVES.

Anatomy—Wounds of Nerves: Changes in nerves after division; Repair and its modifications; Clinical features; *Primary and secondary suture*—Subcutaneous Injuries of Nerves—Diseases: *Neuritis; Tumours*—Surgery of the individual nerves: *Brachial neuralgia; Sciatica; Trigeminal neuralgia.*

**Anatomy.**—A nerve-trunk is made up of a variable number of bundles of nerve fibres surrounded and supported by a framework of connective tissue. The nerve fibres are chiefly of the medullated type, and they run without interruption from a nerve cell or "neuron" in the brain or spinal cord to their peripheral terminations in muscle, skin, and secretory glands.

Each nerve fibre consists of a number of nerve fibrils collected into a central bundle—the axis cylinder—which is surrounded by an envelope, known as the neurilemma or sheath of Schwann. Between the neurilemma and the axis cylinder is the medullated sheath composed of a fatty substance known as myelin. This medullated sheath is interrupted at the nodes of Ranvier, and in each internode is a nucleus lying between the myelin and the neurilemma. The axis cylinder is the essential conducting structure of the nerve, while the neurilemma and the myelin act as insulating agents. The axis cylinder depends for its nutrition on the central neuron with which it is connected, and from which it originally developed.

The connective-tissue framework of a nerve-trunk consists of the *perineurium*, or general sheath, which surrounds all the bundles; the *epineurium*, surrounding individual groups of bundles; and the *endoneurium*, a delicate connective tissue separating the individual nerve fibres. The blood-vessels and lymphatics run in these connective-tissue sheaths.

According to Head and his co-workers, Sherren and Rivers, the afferent fibres in the peripheral nerves can be divided into three systems:—

1. Those which subserve *deep sensibility* and conduct the impulses produced by pressure. The fibres of this system run with the motor nerves and pass to muscles, tendons, and joints. Even division of both the ulnar and the median nerve above the wrist produces little loss of deep sensibility, unless the tendons are also cut through. A want of appreciation of this form of sensibility has been largely responsible for

the conflicting statements as to the sensory disturbances following the division and the repair of nerves.

2. Those which subserve *protopathic* sensibility, that is, are capable of responding to painful cutaneous stimuli and to the extremes of heat and cold. These also endow the hairs with sensibility to pain.

3. Those which subserve *epicritic* sensibility, the most highly specialised, capable of responding to light touch with a well-localised sensation, of appreciating the finer grades of temperature called cool and warm (72-104° F.), and of discriminating as separate the points of a pair of compasses 2 cms. apart.

## Injuries of Nerves.

Nerves are liable to be injured in various ways: thus they may be cut or torn across, bruised, compressed, stretched, or torn away from their connections with the spinal cord.

*Complete division* is a common result of accidental wounds, especially above the wrist, where the ulnar, median, and radial nerves are frequently cut across.

The mere interruption of the continuity of a nerve results in degeneration of its fibres, the myelin being broken up into droplets and absorbed, while the axis cylinders swell up, disintegrate, and finally disappear. Both the conducting and the insulating elements are thus lost. The degeneration in the central end of the divided nerve is usually limited to the immediate proximity of the lesion, and does not involve all the nerve fibres. In the distal end, it is generally believed to extend throughout the entire peripheral distribution of the nerve, because the fibres are cut off from their trophic nerve cells in the spinal cord. The amount of degeneration, however, would appear to depend largely upon whether the ends are reunited or not, and on the length of time they remain apart. If there is a gap left between them, or if they are separated by scar tissue, the peripheral end undergoes complete degeneration in from six weeks to two months. If, however, the ends are in contact, degeneration may take place only to a very limited extent.

**Process of Repair when the Ends are in Contact.**—*If the wound is aseptic*, the ends of the divided nerve become united, and the conducting paths are established by a regeneration of nerve fibres. There is a difference of opinion as to the method of regeneration. According to one view, the divided axis cylinders in the central end grow downwards and enter the nerve sheaths of the distal portion, and continue growing until they reach the peripheral terminations in muscle and skin, and in course of time they acquire a myelin sheath. The other view is that the formation of new axis cylinders is not confined to the

central end, but that it goes on also in the peripheral segment, in which, however, the new axis cylinders do not attain maturity until continuity with the central end has been re-established. Whether it is entirely from the central end or by participation of both segments, proximal and distal, the young axis cylinders, which are the essential element in the repair of nerves, are derived from the nuclei which lie beneath the neurilemma.

*If the wound becomes infected* and suppuration occurs, scar tissue is formed in considerable amount, and this exercises injurious pressure upon the young nerve fibres, with the result that the conducting paths are not reproduced.

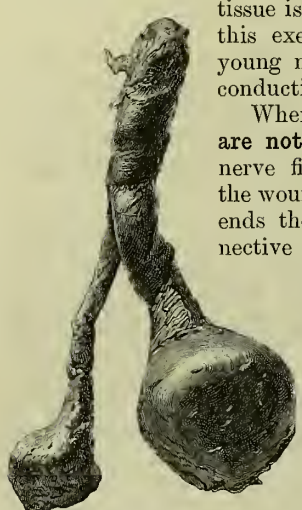


Fig. 71.—Stump Neuromata of Sciatic Nerve, excised forty years after the original amputation by Mr. A. G. Miller.

When the **ends of the divided nerve are not in contact**, reunion of the divided nerve fibres does not take place whether the wound is septic or aseptic. Between the ends there is a mass of newly formed connective tissue, which varies in amount according to the duration of the reparative process and the length of time the ends remain apart. The proximal end of the nerve forms a bulbous swelling, which becomes adherent to the general scar tissue, and consists of branching axis cylinders running in all directions. These have failed to reach the distal end because of the distance between them. The peripheral end is completely degenerated, and is represented by a fibrous cord, the cut end of which is often slightly swollen or bulbous, and is also incorporated with the general scar tissue of the wound.

In the case of *nerves divided in an amputation* there is an active, although necessarily abortive, attempt at regeneration, which results in the formation of bulbous swellings at the cut ends of the nerves. When there has been suppuration, and especially if the nerves have been cut low down so as to be exposed in the wound, these bulbous swellings may attain an abnormal size, and are then known as "amputation" or "stump neuromata" (Fig. 71).

When a nerve is only *partially divided*, those fibres which

are severed form new axis-cylinder processes, which are conducted across the gap by the intact fibres, and, provided the wound is aseptic, the conducting paths are re-established. In septic wounds the reparative process may be incomplete on account of the formation of scar tissue between the divided fibres.

When a nerve is *torn across* or is badly *crushed*—as, for example, by a fractured bone—the changes are very similar to those in a divided nerve, and the ultimate result depends on the amount of separation between the ends and the possibility of the young axis cylinders bridging the gap.

*Contusion* of a nerve-trunk may be attended with extravasation of blood into the connective-tissue sheaths, and certain of the contused nerve fibres may undergo degeneration. Function is usually restored, the conducting paths being re-established by the formation of new nerve fibres.

**Symptoms resulting from Division and Non-Union of a Nerve-Trunk.**—These necessarily vary with the functions of the affected nerve. We shall take as an example a mixed sensori-motor trunk, such as the median or musculo-spiral.

*Sensory Phenomena.*—While sensation is being tested the patient's eyes are closed, and he is asked to indicate whenever he experiences a touch, a prick, or any other sensation. Superficial touch is tested by means of a wisp of cotton wool stroked gently across the skin. The capacity of discriminating two points as separate is investigated with a pair of blunt-pointed compasses. The sensation of pressure is tested by means of a pencil or other blunt object; of pain, by means of a sharp needle. Sensibility to heat and cold is investigated by using test-tubes containing water at different temperatures.

Division of a nerve containing sensory fibres results in an area of absolute cutaneous insensibility to touch (anæsthesia), to pain (analgesia), and to all degrees of temperature, surrounded by an area of loss of sensation to light touch, minor differences of temperature (72-104° F.), and discrimination of the two points of a compass (Head and Sherren) (Figs. 76, 78).

*Motor Phenomena.*—There is immediate and complete loss of voluntary power in all the muscles supplied by the divided nerve. The muscles rapidly waste, and usually within from three to five days they cease to react to the faradic current. When tested with the galvanic current they present the "reaction of degeneration," and after a few weeks all electric excitability is lost. The paralysed muscles undergo fatty degeneration, which attains its maximum three or four months after the division of the nerve. Further changes may take place, and

result in the transformation of the muscle into fibrous tissue, which by undergoing shortening may cause deformity known as *paralytic contracture.*

*Vaso-motor Phenomena.*—In the majority of cases there is an initial rise in the temperature of the part (2° to 3° F.), with redness and increased vascularity. This is followed by a fall in the local temperature, which may amount to 8° or 10° F., the parts becoming pale and cold. Sometimes the hyperæmia resulting from vaso-motor paralysis is more persistent, and is associated with swelling of the parts from œdema—the so-called *angio-neurotic œdema* The vascularity varies with external influences, and in cold weather the parts present a bluish appearance.

*Trophic Phenomena.*—Owing to the disappearance of the subcutaneous fat, the skin is generally smooth and thin, and it may be abnormally dry. The hair is harsh, dry, and easily shed. The nails may become brittle and furrowed, or thick and curved, and the ends of the fingers become club-shaped. Skin eruptions, especially in the form of blisters, may occur, or there may be actual ulcers of the skin, especially in the winter months (Fig. 17). In aggravated cases the tips of the fingers may disappear from progressive ulceration, and in the sole of the foot the condition may assume the characters of the perforating ulcer. Arthropathies are occasionally met with, the joints becoming the seat of a painless effusion or hydrops, which is followed by fibrous thickening of the capsular and other ligaments, and terminates in stiffness and fibrous ankylosis. The fingers may be seriously crippled and deformed.

When a nerve is *incompletely divided* the injury may produce the most varying results upon muscular power and on the reaction to electrical stimulation. In many cases the muscles supplied by the injured nerve do not lose voluntary power, and they react normally to both forms of electrical stimulation. Voluntary power may remain while reaction to the interrupted current is lost; the muscles will then respond more readily to the constant current. The contraction still occurs to the negative pole more readily than to the positive, and the strength of current necessary to cause contraction is considerably reduced. This facile reaction to the constant current also occurs when voluntary power is lost and all response to the interrupted current is abolished. It is therefore a valuable indication that the nerve has not been completely severed (Head and Sherren).

**Treatment of Divided Nerves.**—The treatment consists in approximating the divided ends of the nerve and placing them

under the most favourable conditions for repair, and this should be done at the earliest possible opportunity.

**Primary Suture.**—The reunion of a recently divided nerve is spoken of as primary suture, and for its success asepsis is essential. As the suturing of the ends of the nerve is extremely painful, an anæsthetic is required. The wound must be enlarged in the long axis of the affected nerve, as the ends—especially the proximal end—are usually retracted. Having identified the ends and brought them into contact, they are secured to each other by the finest chromicised catgut or silk passed by a round needle, such as is used for the intestine. The sutures are made to transfix the ends of the nerve and the sheath, and should only be drawn tight enough to obtain accurate apposition. Additional sutures may be passed through the sheath around the circumference. If the ends of the nerve are bruised or torn, fresh surfaces should be obtained by cutting them across. If the nerve is only partially divided, it may be sufficient to pass a few sutures through the sheath. Tension on the sutures may be relieved by flexing adjacent joints and fixing the limb in a splint. When the wound is healed, measures are employed to maintain the nutrition of the damaged nerve and of the parts supplied by it, while waiting for the restoration of function. The limb is exercised, massaged, and douched, and protected from cold and other influences which may provoke trophic changes. The nutrition of the paralysed muscles is further improved by electricity. The galvanic current is employed, using at first a mild current of not more than five milliampères for about ten minutes, the current being made to flow downwards in the course of the nerve, with the positive electrode applied to the spine, and the negative over the affected nerve near its termination. It is an advantage to have a key in the circuit whereby the current can be opened and closed at intervals, so as to cause contraction of the muscles.

*The results* of primary suture, when it has been performed under favourable conditions, are usually satisfactory. In a series of cases accurately investigated by Head and Sherren, the period between the operation and the first return of sensation averaged 65 days. The length of time necessary for the return of sensibility to light touch and intermediate degrees of temperature varied, but in the majority of cases it was about one year. The return of voluntary motor power in the paralysed muscles and their contractibility to the interrupted current averaged 346 days. When sensation returns the area of insensibility to pain steadily diminishes and disappears; sensibility to extremes of

temperature appears very soon after; and last of all, after a considerable interval, there is simultaneous return of appreciation of light touch, moderate degrees of temperature, and the two points of a compass.

Primary suture should not be attempted so long as the wound shows signs of inflammation or suppuration, as it is almost certain to end in failure. The ends should be sutured, however, as soon as the wound is aseptic or has healed.

**Secondary Suture.**—The stitching of the ends of a nerve in a wound which has already healed is known as secondary suture. The operation of uniting a divided nerve is more difficult in a wound which has healed, because the ends are usually involved in scar tissue. An incision is made in the line of the nerve, and the cut ends sought for. If they cannot be identified in the scar tissue, they will be found at a little distance above and below, in their normal anatomical situation. The ends of the nerve, after being freed from the scar tissue, are trimmed with scissors and approximated by sutures as already described. If a tourniquet is employed, it should be removed as soon as the ends of the nerve have been isolated, in order to minimise its pressure effects.

*Results of Secondary Suture.*—When secondary suture has been performed under favourable conditions the prognosis is good, but a much longer time is required for complete restoration of function than after primary suture. Sensation is recovered first, but it seldom returns before three or four months. There then follows an improvement or disappearance of any trophic disturbances which may be present. Recovery of motion may be deferred for long periods—rather because of the changes in the muscles than from want of conductivity in the nerve—and if the muscles have undergone complete degeneration, it may never take place at all. While waiting for recovery, every effort should be made to maintain the nutrition of the damaged nerve and of the parts which it supplies by the measures already described.

If it is impossible to bring the ends into contact, recourse must be had to other methods. For example, the gap may be bridged across by strands of fine catgut or by a portion of nerve obtained from an animal or a recently amputated limb. When catgut is employed, it is a useful addition to slip a decalcified bone tube over the ends of the nerve and across the gap. The practice of turning down flaps from the ends of the nerve is of doubtful value, as such portions usually degenerate. Resection of a portion of bone so as to shorten the segment of limb con-

eerned has been sueeessfully praetised in the upper arm (Annandale). When the gap between the ends is very wide, the ends may be splieed into the nearest intaet nerve-trunk—for example, the widely separated ends of the median nerve may be attached to the ulnar. The results of this proeedure—which has been ealled *nerve implantation*—are often most satisfaetory.

*Injuries of nerves resulting from* **gun-shot wounds** may be eonsidered under two heads:—(1) those in whieh the nerve is directly damaged by the bullet, and (2) those in whieh the nerve-trunk is involved seeondarily either in scar tissue in its vieinity or in eallus following fraeture of an adjaeent bone. The primary injuries inelude eontusions, partial or eomplete division and perforation of the nerve-trunk. *Contusions* vary greatly in severity and present the same range of clinieal features as have been deseribed with the subeutaneous injuries of nerves; if there is suppuration in the associated wound, the symptoms of disordered funetion are liable to be more pronouneed and persistent. Division, partial or eomplete, of a nerve-trunk by a bullet is attended by the same signs of interrupted eonduetion as when the nerve is divided by other means.

The treatment is eonducted on the same lines as in other injuries of nerves.

**Involvement of Nerves in Scar Tissue.**—This applies to the implieation of nerve-trunks which were not themselves affeeted by the original lesion. A suppurating wound or an abseess in the vieinity of a nerve-trunk may eause injurious pressure or traetion upon the nerve by the contraeting sear tissue, or may induee in it a process of neuritis or perineuritis. The symptoms are very similar to those of neuritis.

When terminal filaments are involved in a scar, it is best to disseet out the sear, and along with it the ends of the nerves pressed upon. When a nerve-trunk, such as the sciatie, is involved in a sear, the nerve must be exposed and freed from its surroundings, and then stretched so as to tear any bands of fibrous tissue whieh may have been overlooked. It may be advisable to displaee the liberated nerve from its original position so as to minimise the risk of its ineorporation in the scar of the original wound or in that resulting from the operation.

When the nerves in an amputation stump have not been eut suffieiently short, they may beeome involved in the eieatrix, and it may be neeessary, on aeeount of pain, to free them from their adhesions, and to reseet enough of the terminal portions to

prevent them again becoming adherent. When this is difficult, a portion may be resected from each of the nerve-trunks at a higher level, and if this fails to give relief, a fresh amputation may be performed. When there is agonising pain dependent upon an ascending neuritis, it may be necessary to resect the posterior nerve roots within the spinal canal.

**Subcutaneous Injuries of Nerves.**—Several varieties of subcutaneous injuries of nerves are met with. One of the best-known examples is the compression paralysis of the nerves of the upper arm which results from sleeping with the arm resting on the back of a chair or the edge of a table—the so-called "drunkard's palsy"; and from the pressure of a crutch in the axilla—"crutch paralysis." A similar form of paralysis is met with from the pressure of a tourniquet, from tight bandages or splints, from the pressure exerted by a dislocated bone or by excessive callus, and from hyperextension of the arm during anæsthesia.

In all these forms there is impaired sensation, rarely amounting to anæsthesia, marked muscular wasting, and diminution or loss of voluntary motor power, while—and this is a point of great importance—the normal electrical reactions are preserved. There may also develop trophic changes such as blisters, superficial ulcers, and clubbing of the tips of the fingers. The prognosis is usually favourable, as spontaneous recovery is the rule within from one to three months. In some cases, however, neuritis supervenes, the muscles degenerate, the electrical reactions are altered, and recovery may be retarded or may fail to take place.

Injuries which act abruptly or instantaneously are illustrated in the crushing of a nerve by the sudden displacement of a sharp-edged fragment of bone, as may occur in comminuted fractures of the humerus. The symptoms include perversion or loss of sensation, motor paralysis, and atrophy of muscles, which show the reaction of degeneration from the eighth day onwards. The presence of the reaction of degeneration influences both the prognosis and the treatment, for it implies a nerve lesion which is probably incapable of spontaneous recovery, and which can only be remedied by operation.

The *treatment* varies with the cause and nature of the lesion. When, for example, a displaced bone or a mass of callus is pressing upon the nerve, steps must be taken to relieve the pressure, by operation if necessary. When there is reason to believe that the nerve is severely crushed or torn across, it should be exposed by incision, and, after removal of the damaged

ends, should be united by sutures. When it is impossible to make a definite diagnosis as to the state of the nerve, it is better to expose it by an exploratory operation and thus arrive at a definite diagnosis without delay, and in the event of the nerve being torn, the ends should at once be united by sutures.

**Dislocation of Nerves.**—This injury, which resembles the dislocation of tendons from their grooves, is seldom met with except in the ulnar nerve at the elbow and is described with injuries of this nerve (p. 349).

## DISEASES OF NERVES.

**Traumatic Neuritis.**—This consists in an overgrowth of the connective-tissue framework of a nerve, which causes irritation and pressure upon the nerve fibres, sometimes resulting in their degeneration, and tends to ascend towards the spinal cord. It may originate in connection with a wound in the vicinity of a nerve, as, for example, when the brachial cords are involved subsequent to an operation for clearing out the axilla for cancer; in a scar; or in contusion and compression of a nerve—for example, by the pressure of the head of the humerus in a dislocation of the shoulder. Some weeks or months after the injury the patient complains of increasing hyperæsthesia and of neuralgic pains in the course of the nerve. The nerve is very sensitive to pressure, and, if superficial, may be felt to be swollen. The associated muscles are wasted and weak, and are subject to convulsive twitchings. There are also trophic disturbances. It is rare to have complete sensory and motor paralysis. The disease is commonest in the nerves of the upper extremity, and the hand is often crippled and useless.

*Treatment.*—Any constitutional condition which predisposes to neuritis, such as gout, diabetes, or syphilis, must receive appropriate treatment. The symptoms may be relieved by rest and by soothing applications such as belladonna or menthol, by the use of hot-air and electric baths, and in obstinate cases by blistering or by the application of Corrigan's button. When such treatment fails the nerve may be stretched, or in the case of a purely sensory trunk a portion may be excised. Local causes such as involvement of the nerve in a scar or in adhesions may afford indications for operative treatment.

**Multiple Peripheral Neuritis.**—Although this disease mainly

comes under the cognisance of the physician, it may be attended with phenomena which call for surgical interference.

It may result from a number of causes, acting singly or in combination. In this country it is most commonly due to alcoholism, but it may result from diabetes or from chronic poisoning with lead or arsenic, or from bacterial infections and intoxications such as occur in diphtheria, gonorrhœa, syphilis, leprosy, typhoid, influenza, beri-beri, and many other diseases.

It is, as a rule, widely and symmetrically distributed throughout the peripheral nerves, but the distribution frequently varies with the cause—the alcoholic form, for example, mainly affecting the legs, the diphtheric form the soft palate and pharynx, and that associated with lead-poisoning the arms. The essential lesion is a degeneration of the conducting fibres of the affected nerves, and the prominent symptoms are the result of this. The sensory phenomena include numbness and tingling, especially in the fingers and toes, and pain and tenderness along the nerves; complete anæsthesia is rare. The motor phenomena include weakness or actual paralysis of muscles, with wasting, loss of the tendon reflexes, and, in advanced cases, the reaction of degeneration. In alcoholic neuritis there is great tenderness of the muscles. When the legs are affected the patient may be unable to walk, and the toes may droop and the heel be drawn up, resulting in one variety of pes equino-varus. Pressure sores and perforating ulcer are the most important trophic phenomena.

Apart from the medical *treatment*—which includes the use of remedies directed towards the cause of the neuritis, and for the relief of pain—measures must be taken to prevent deformity, especially when the legs are affected. The bed-clothes are supported by a cage, and the feet maintained at right angles to the legs by sand-bags or splints. When the disease is subsiding the nutrition of the damaged nerves and muscles should be maintained by massage, baths, passive movements, and the use of the galvanic current.

## NEUROMATA.

Neuroma is a clinical term applied to all tumours, irrespective of their structure, which have their seat in nerves.

Tumours which are composed of newly formed nerve tissue are spoken of as *true neuromata*; when ganglionic cells are present in addition to nerve fibres, the name *ganglionic neuro-*

*mata* is applied. These tumours are very rare, and are chiefly met with in the main cords or abdominal plexuses of the sympathetic system of children or young adults. They may be solitary or multiple, circumscribed or diffused, and they are quite insensitive. Being usually innocent, their removal is only called for if they cause inconvenience.

*The false neuromata* are connective-tissue overgrowths of the sheaths of nerves. This overgrowth may result in the formation of a circumscribed tumour, or may take the form of a diffuse fibromatosis.

*The circumscribed or solitary tumours* grow from the sheaths of nerves which are otherwise healthy, and they may be innocent or malignant.

*The innocent* forms are usually fibrous or myxomatous, and are definitely encapsulated. They may become cystic as a result of hæmorrhage or of myxomatous degeneration. They grow very slowly, are usually elliptical in shape, and the solid forms are rarely larger than a hazel nut. The nerve fibres may be spread out all round the tumour, or may run only on one side of it. When subcutaneous and related to the smaller unnamed cutaneous nerves they are known as *painful subcutaneous nodules* or *tubercles*. These are chiefly met with in the lower extremities, and especially in women. They are remarkably sensitive, even gentle handling causing intense pain, which usually radiates to the periphery of the nerve affected. When related to deeper, named nerve-trunks they are known as *trunk neuromata*. These are usually less sensitive than the "subcutaneous nodule," and they rarely give rise to motor symptoms unless when involving the nerve roots within the spinal canal.

The origin of these swellings from nerves is recognised clinically by their position in the line of a nerve, by the fact that they are movable in the transverse axis of the nerve but not in its long axis, and by their being painful and sensitive.

*Treatment.*—If they cause much suffering they should be removed, preferably by shelling them out from the investing nerve sheath or capsule. If the nerve is damaged the portion to which the tumour is attached should be resected and the ends sutured. In the subcutaneous nodule the nerve is rarely recognisable, and is usually sacrificed.

*The malignant neuroma* is really a sarcoma growing from the sheath of a nerve. It has the same characters and clinical features as the innocent neuroma, only it grows more rapidly, and by destroying the nerve fibres causes motor symptoms—jerkings followed by paralysis. The sarcoma tends to spread

along the lymphatic spaces of the affected nerve-trunks, as well as to implicate the surrounding tissues, and is liable to give rise to secondary growths. The malignant neuroma is met with chiefly in the great sciatic and other large nerves of the limbs.

The best *treatment* is to amputate the limb well above the growth, as mere removal of the tumour is usually followed by recurrence. In hopeless cases it may be possible to relieve pain by excising a portion of the nerve above the tumour, or, when this is impracticable, by resecting the posterior nerve roots and their ganglia within the spinal canal.

The so-called *amputation neuromata* have already been referred to (p. 330).

*Diffuse or Generalised Neuro-Fibromatosis—Elephantiasis Nervorum.*—These terms are now used to include what were formerly known as "multiple neuromata," as well as certain

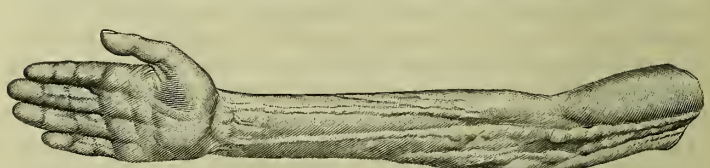


Fig. 72.—Diffuse Enlargement of Nerves in generalised Neuro-Fibromatosis.

(After R. W. Smith.)

other overgrowths related to nerves. The essential lesion is a diffuse or a generalised overgrowth of the endoneural connective tissue throughout the nerves of both the cerebro-spinal and sympathetic systems. The nerves are diffusely and unequally thickened, so that small twigs may become enlarged to the size of the median, while at irregular intervals along their course the connective-tissue overgrowth is exaggerated so as to form tumour-like swellings very similar to the trunk neuromata already described. The tumours, which vary greatly in size and number—as many as a thousand or more having been counted in one case—are enclosed in a capsule derived from the nerve sheath. The fibromatosis may also affect the cranial nerves, the ganglia on the posterior nerve roots, the nerves within the spinal canal, and the sympathetic nerves and ganglia, as well as the continuations of the motor nerves within the muscles. The nerve fibres, although mechanically displaced and dissociated by the overgrown endoneurium, usually undergo no structural change.

The disease probably originates before birth, although it may

not make its appearance till adolescence or even till adult life. It is sometimes met with in several members of one family. It is recognised clinically by the presence of multiple tumours in the course of the nerves, and sometimes by palpable enlargement of the superficial nerve-trunks (Fig. 72). The tumours closely resemble the solitary trunk neuromata, and they often remain quite insensitive. As a result of injury or other exciting cause, however, one or other tumour may increase in size and become extremely sensitive. The pain is much increased by handling, and may interfere with sleep. Motor disturbances are exceptional, unless in the case of tumours within the spinal canal, which sometimes cause paraplegia. Neurofibromatosis is frequently accompanied by pigmentation of the skin in the form of brown spots or patches.



Fig. 73.—Plexiform Neuroma of small Sciatic Nerve, from a girl aged 16.
(Mr. Annandale's case.)

The disease is often stationary for long periods. In progressive cases the patient becomes exhausted, and usually dies of some intercurrent affection, particularly phthisis. The treatment is restricted to relieving symptoms and complications.

In a considerable proportion of cases one or other of the multiple tumours takes on the characters of a malignant growth ("secondary malignant neuroma," Garré). This malignant transformation may follow upon injury, or on the incomplete removal of the tumour. The features are those of a rapidly growing sarcoma involving a nerve-trunk, with agonising pain and muscular cramps, followed by paralysis from destruction of the nerve fibres. The removal of the tumour is usually followed by recurrence both in the nerve affected and in other nerves, so that high amputation is the only treatment to be recommended. Metastasis to internal organs is exceptional.

There are certain special types of neuro-fibromatosis which require brief mention.

*The plexiform neuroma* (Fig. 73) is a fibromatosis confined to

the distribution of one or more contiguous nerves or of a plexus of nerves, and it may occur either by itself or along with a generalised neuro-fibromatosis. The clinical features are those of an ill-defined swelling composed of a number of tortuous, convoluted cords, lying in a loose areolar tissue and freely movable on one another. It is rarely the seat of pain or tenderness. It most often appears in the early years of life, sometimes in relation to a pigmented or hairy mole. It is usually subcutaneous, and is frequently situated on the head or neck in the distribution of the trigeminal or superficial cervical nerves. The results of excision are satisfactory, even if the removal is not quite complete.

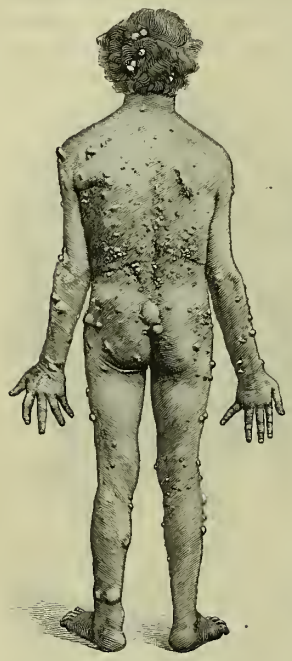


FIG. 74.—Multiple Neuro-Fibromata of Skin (Molluscum fibrosum).

(After von Recklinghausen.)

*The cutaneous neuro-fibroma or molluscum fibrosum* has been shown by von Recklinghausen to be a soft fibroma related to the terminal filaments of the cutaneous nerves (Fig. 74). The disease appears in the form of multiple, soft, projecting tumours of the skin, which are scattered over the body—except on the palms of the hands and soles of the feet—and are frequently associated with pigmentation of the skin and with multiple tumours of the nerve-trunks. In exceptional cases one of the skin tumours may attain an enormous size and cause a hideous deformity, hanging down by its own weight in lobulated or folded masses (pachydermatocele). They are very closely related to the plexiform neuroma, and the skin over them may be pigmented and hairy. The treatment consists in the removal of the larger swellings, but the small multiple tumours rarely call for interference.

*Elephantiasis neuromatosa* is the name applied by Virchow to a condition in which a limb is swollen and misshapen as a result of the extension of a neuro-fibromatosis to the skin and cellular tissue of the extremity as a whole. While it resembles other forms of elephantiasis, it usually begins in early life

without apparent cause, and it may be associated with multiple tumours of the nerve-trunks. The inconvenience caused by the bulk and weight of the limb may justify its removal by amputation.

## SURGERY OF THE INDIVIDUAL NERVES.[1]

**The brachial plexus** may be contused by such accidents as the wheel of a cart striking the root of the neck, displacement of the fragments in a fracture of the clavicle, or forcible abduction of the arm during anæsthesia, the cords being compressed between the clavicle and first rib. The nerve roots may be torn from their origin by violent traction of the arm upwards and backwards —as by clutching an object when falling from a height. The nerve-trunks in the axilla may be bruised and compressed in dislocation of the head of the humerus, in fractures of the neck of the scapula and neck of the humerus.

The symptoms vary with the nature and extent of the lesion. When all the cords are ruptured, the arm hangs powerless by the side, and is anæsthetic save over the upper deltoid region. If the first dorsal root is torn close to its point of emergence from the intervertebral foramen, there is paralysis of the sympathetic fibres to the eye and orbit, with narrowing of the palpebral fissure and recession of the globe, and the pupil is slow to dilate when shaded from the light. The usual trophic changes supervene in the arm, and the humerus is displaced downwards by the weight of the limb.

In partial lesions, the fifth and sixth cervical roots most often suffer. They are liable to be stretched if the patient in falling lands on the shoulder, while the head on touching the ground is forced towards the opposite side, so that a considerable stretching force is exerted along the line of the nerves implicated (Victor Horsley). There is anæsthesia on the outer aspect of the arm and forearm; paralysis of the deltoid, biceps, brachialis anticus, and supinator longus and brevis muscles (Erb's group of muscles); and pain in the neck and down the arm.

The prognosis varies with the nature of the lesion. When the roots are torn from the cord it is very unfavourable. The patient requires a support for the elbow, or it may be advantageous to bring about ankylosis of this joint in the flexed

[1] The cranial nerves are considered with affections of the head and neck (vol. ii. chap. iv.).

position, because of the paralysis of its flexors. When the nerve cords are ruptured the question of uniting them by operation arises. Satisfactory results have been obtained from suture of the cords (Thorburn).

In the *birth palsies of the upper extremity in children*—first described by Duchenne—the fifth and sixth cervical cords are those usually affected. There is often a history of considerable force having been employed during the birth of the child whereby the nerve cords are bruised or stretched. If there is no prospect of spontaneous recovery, as indicated by the development of abnormal electrical reactions in the affected muscles, the nerve-trunks may be exposed above the clavicle; according to the conditions met with they are freed from adhesions, or, if necessary, resected and sutured (Robert Kennedy).

When the brachial cords are compressed by a cervical rib, a tumour, or a subclavian aneurysm, there is pain and motor weakness in the arm, which are treated by the removal of the compressing cause when this is possible.

**The nerve of Bell**, which supplies the serratus magnus, may be contused or stretched as a result of injuries to the shoulder, from carrying heavy weights on the shoulder, or from prolonged exertion with the arm raised. The serratus being paralysed, the patient complains of diminished power of elevating the arm above the shoulder, and on examination the vertebral border of the scapula is found to project from the thorax, especially when the arms are stretched out in front "winged scapula." The arm must be rested and supported in a sling so adjusted as slightly to raise the shoulder, and the functions of the nerve and muscle are promoted by massage and electricity.

**The supra-scapular nerve** may be paralysed as a result of injuries to the shoulder. The supra- and infra-spinatus muscles are paralysed and wasted, the spine of the scapula becomes unduly prominent, and there is some impairment in the power of raising the arm, and of the finer movements in writing or sewing (Thorburn).

**The circumflex nerve** is frequently damaged in injuries in the region of the shoulder. The deltoid muscle is paralysed and wastes rapidly, and the arm cannot be raised to the horizontal position. The *sub-scapular nerves* may be injured at the same time, leading to paralysis of the muscles supplied by them. Bilateral paralysis of the deltoid has followed sleeping with the arms raised and the hands clasped behind the head.

**Musculo-Spiral Nerve.**—In virtue of its anatomical relationships this trunk is more exposed to injury than any other nerve

in the body. It is frequently compressed against the humerus in sleeping with the arm resting on the back of a chair, especially in the deep sleep of alcoholic intoxication (drunkard's palsy). It may be pressed upon by a crutch in the axilla, by the dislocated head of the humerus, or by violent squeezing of the upper arm, as when an elastic tourniquet is applied too tightly. The most serious and permanent injuries of the nerve are associated with fractures of the humerus, especially those from direct violence attended with comminution. The nerve may be crushed or torn by one of the fragments at the time of the injury, or at a later period may be compressed by callus.

*Clinical Features.*—It is impossible to tell clinically whether the nerve is torn across or merely compressed. The patient may complain of numbness and of tingling in the distribution of the radial nerve, but there is rarely any definite loss of sensation.



Fig. 75.—Drop-Wrist from Musculo-Spiral Paralysis, the result of wound of upper arm.

The motor symptoms predominate, the muscles affected being the extensors of the wrist and fingers, and the supinators. If the lesion is high up, as it is, for example, in crutch paralysis, the triceps and anconeus may also suffer. There is a characteristic "drop-wrist"; the wrist is flexed and pronated, and the patient is unable to dorsiflex the wrist or fingers (Fig. 75). If the hand and proximal phalanges are supported, the second and third phalanges may be partially extended by the interossei and lumbricals. There is also considerable impairment of power in the muscles which antagonise those that are paralysed, so that the grasp of the hand is very feeble, and the patient almost loses the use of it.

*Treatment.*—The slighter forms of injury by compression recover under massage, douching, and electricity. If there is drop-wrist, the hand and forearm are placed on a palmar splint, with the hand dorsiflexed to nearly a right angle, and this position is maintained until the voluntary dorsiflexion at the

wrist returns to the normal. The extensor muscles should be massaged and beaten with a vibrator.

In the more severe forms associated with fracture of the humerus and attended with the reaction of degeneration, it is necessary to cut down upon the nerve and free it from the pressure of a fragment of bone or from callus or adhesions. If the nerve is torn across the ends must be sutured, and if there is a wide gap between them it may be necessary to resect a portion of the humerus to obtain apposition. If the central end cannot be found or if the gap is very great, the peripheral end may be grafted into the median nerve.

Finally, in cases where the paralysis is permanent and incurable, the disability may be relieved by the transplantation of tendons. The healthy flexor carpi ulnaris is divided, its central end drawn underneath the extensor of the same name, and grafted into the common extensor of the fingers. Similarly the flexor carpi radialis may be divided and drawn beneath the first two extensors of the thumb, and grafted into the tendon of the extensor longus pollicis. After this procedure the patient may recover the use of the thumb and fingers. The extensors of the wrist may be shortened, so as to place the hand in the position of dorsal flexion, and thus improve the attitude and grasp of the hand.

**The radial nerve** suffers in lesions of the musculo-spiral of which it is a branch, and is itself liable to be divided in cuts about the wrist.

**The median nerve** may be contused, compressed, or divided in the upper arm or at the bend of the elbow. It is, however, more frequently divided in transverse wounds immediately above the wrist. In the forearm it supplies the pronators, the flexors of the wrist and fingers (excepting the flexor carpi ulnaris and the ulnar half of the flexor profundus), and the flexor longus pollicis. In the hand it supplies the opponens, the abductor and the outer head of the short flexor of the thumb, and the two radial lumbricals, so that wherever the nerve is injured these muscles are apt to be affected. The thumb remains in an extended and abducted position and cannot be opposed to the tips of the fingers, and there is wasting of the ball of the thumb. In those cases in which the nerve is injured above the origin of the branches to the muscles in the forearm, the hand cannot be pronated, and the wrist cannot be flexed except to the ulnar side. The patient is unable to flex the second phalanges on the first or to flex the distal phalanx of the index and middle fingers. He can, however, flex at the knuckles by the action of the interossei. The sensory

changes vary in different cases, but in the majority there is total loss of sensation over the dorsal and palmar surfaces of the two

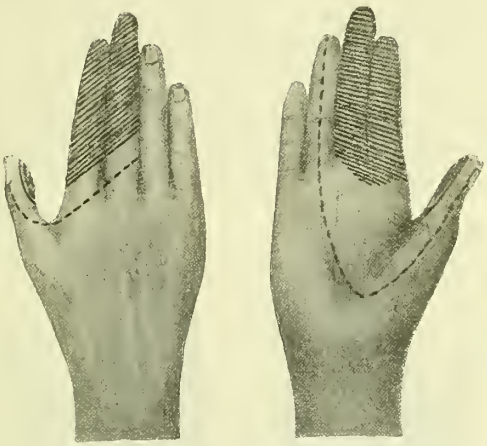


FIG. 76.—To illustrate the Loss of Sensation produced by Division of the Median Nerve. The area of complete cutaneous insensibility is shaded black. The parts insensitive to light touch and to intermediate degrees of temperature are enclosed within the dotted line. (After Head and Sherren.)

terminal phalanges of the index and middle fingers, while it is impaired over a wider area which nearly corresponds to the

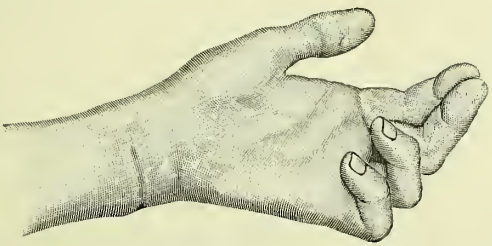


FIG. 77.—Claw-hand following Division of Ulnar Nerve above Wrist.

anatomical distribution of the nerve (Fig. 76). The skin of the finger tips and the nails may suffer from trophic changes (Fig. 17).

**The Ulnar Nerve.**—The most common injury of this nerve is

its division in transverse accidental wounds just above the wrist. In the upper arm it may be contused, along with the musculo-spiral, in crutch paralysis. In the groove behind the elbow it may be contused by a blow, or compressed or torn in fractures of the internal condyle of the humerus, or it may be accidentally divided in the operation for excising the elbow-joint.

In the forearm it supplies the flexor carpi ulnaris and the ulnar half of the flexor profundus digitorum; and in the hand, the short muscles of the little finger, the interossei, the two ulnar

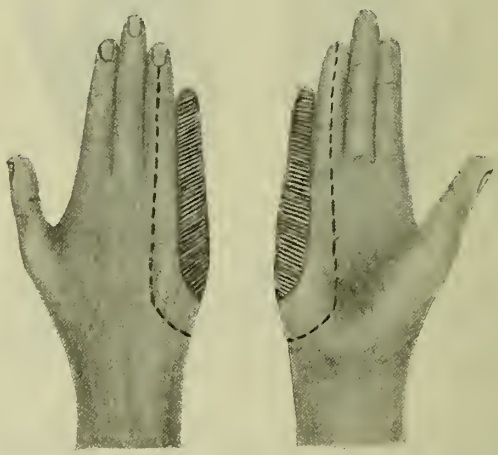


Fig. 78.—To illustrate Loss of Sensation produced by complete Division of Ulnar Nerve. Loss of all forms of cutaneous sensibility is represented by the shaded area. The parts insensitive to light touch and to intermediate degrees of heat and cold are enclosed within the dotted line. (Head and Sherren.)

lumbricals, the adductor, and inner head of the flexor brevis pollicis.

When divided just above the wrist, owing to the resulting paralysis of the interossei and inner lumbricals, the fingers cannot be flexed at the metacarpo-phalangeal joints or extended at the inter-phalangeal joints, the disability chiefly affecting the ring and little fingers. The fingers can neither be adducted nor abducted, and the interosseous spaces are hollowed out from wasting of the interossei. There is loss of adduction of the thumb, and of abduction of the little finger, which can no longer be opposed to the thumb. There is wasting of the hypothenar,

and of the ulnar portion of the thenar eminence. In time the contraction of the opponents of the paralysed interossei produces over-extension of the first phalanges and flexion of the others, so that a "claw hand" or *main en griffe* develops, the claw attitude chiefly affecting the ring and little fingers (Fig. 77). The skin and nails of the ring and little fingers often present trophic changes.

When the nerve is injured above the origin of the branches to the muscles in the forearm, the hand when flexed deviates to the radial side, and in time this deviation becomes permanent, and the grasp of the hand is weakened, especially in the ring and little fingers.

There is complete loss of sensation over an area which may vary greatly in size; sometimes it includes the little finger, the ulnar half of the ring finger, and one-third of the palm and dorsal surface of the hand; in other cases it is reduced to the little finger and a strip on the extreme ulnar border of the hand (Fig. 78). Sensation is impaired over a wider area corresponding to the anatomical distribution of the nerve.

**Dislocation of the ulnar nerve** at the elbow may result from a direct blow, or from a muscular effort which causes stretching or laceration of the fascia which holds the nerve in its groove; it is predisposed to if the groove is shallow as a result of imperfect development of the internal condyle of the humerus.

The nerve slips forward, and may be felt lying on the inner aspect of the condyle. It may retain this position, or it may slip backwards and forwards with the movements of the arm. The symptoms at the time of the displacement are a certain amount of disability at the elbow, and pain and tingling along the nerve, which are exaggerated by movement and by pressure. The symptoms may subside altogether, or a neuritis may develop with severe pain shooting up the nerve.

The dislocated nerve is easily replaced, but is difficult to retain in position. In recent cases the arm may be placed in the extended position with a pad over the condyle, care being taken to avoid pressure on the nerve. Failing relief, it is better to make a bed for the nerve by dividing the deep fascia behind the internal condyle and stitching the edges of the fascia over the nerve. This operation has been successful in all the recorded cases.

**The external popliteal nerve** is most exposed to injury where it winds round the neck of the fibula. It may be compressed by a tight bandage or tourniquet, or it may be bruised or torn in

fractures of the upper end of the bone. It has been divided in accidental wounds—by a scythe, for example—and in performing subcutaneous tenotomy of the biceps tendon. Cases have been observed of paralysis of the nerve as a result of prolonged acute flexion of the knee in certain occupations.

When the nerve is paralysed the most obvious result is "drop-foot." The patient is unable to dorsiflex the foot and cannot lift his toes off the ground, so that in walking he is obliged to throw or jerk the foot forwards and outwards. There is loss of all sensibility over the dorsum of the foot and of sensibility to light touch over a considerable portion of the outer aspect of the leg. In course of time the foot becomes markedly inverted and the toes are pointed—pes equino-varus—and trophic sores are liable to form.

**The internal popliteal nerve,** from its anatomical situation, is but rarely injured.

**The sciatic nerve** also is little exposed to injury. When it is compressed, as by sitting on a fence, there is tingling and powerlessness in the limb as a whole, but these phenomena are usually evanescent. This is commonly known as sleeping of the limb. The most important surgical lesion of the nerve-trunk is when a portion of it has been resected in removing a tumour. Although the limb is at first quite powerless, the patient usually recovers sufficiently to be able to walk without a support. The chief clinical feature is "drop-foot." Although the hamstrings are paralysed, the knee can still be flexed by the sartorius and gracilis. The foot is usually cold and bluish, and may present trophic sores. The skin is anæsthetic except in the distribution of the long saphenous nerve, on the inner aspect of the lower half of the leg and inner side of the foot.

*The anterior crural and obturator nerves* are so rarely injured that they do not merit separate consideration.

## NEURALGIA.

The term neuralgia is applied clinically to any pain which follows the course of a particular nerve and its branches, and which is not referable to any definite lesion of the nerve, or to any other discoverable cause. This term should not be applied to pain which results from pressure on a nerve by a tumour, a mass of callus, an aneurysm, or by any similar gross lesion.

We shall only consider here those forms of neuralgia which are amenable to surgical treatment.

**Brachial Neuralgia.**—One or more of the roots or branches of the brachial plexus may be the seat of pain. The pain is definitely located in the distribution of one of the branches or nerve roots, is often intermittent, and is usually associated with tingling and disturbance of tactile sensation. It may be due to a localised neuritis, or no cause can be discovered. The region of the root of the neck should be carefully examined to exclude the pressure of a cervical rib, a tumour, or an aneurysm as a cause of the pain. When medical treatment fails, recourse may be had to operative measures. The affected cords are exposed and stretched through an incision in the posterior triangle of the neck, commencing at the outer border of the sterno-mastoid at the junction of its middle and lower thirds, and passing outwards and downwards to the junction of the outer and middle thirds of the clavicle. If this operation fails to give relief, the posterior roots of the affected nerves may be resected within the spinal canal.

*Neuralgia of the great sciatic nerve*—**sciatica**—is the most common form of neuralgia met with in surgical practice.

A definite cause of the pain is rarely ascertainable. The condition is chiefly met with in adults of gouty or rheumatic tendencies who suffer from indigestion, constipation, and oxaluria—in fact, in the same type of patients who are liable to lumbago, and the two affections are frequently associated in the same person. In hospital practice it is commonly met with in coal-miners and others who assume a squatting position at work. The actual onset of the pain may follow over-exertion and exposure to cold and wet, especially in those who do not take regular exercise. Any error of diet or excessive indulgence in beer or wine may contribute to its development.

The essential symptom is paroxysmal or continuous pain along the course of the nerve in the buttock, thigh, or leg. It may be comparatively slight, or may be so severe as to prevent sleep. It is usually aggravated by movement, so that the patient walks lame or is obliged to lie up. It is aggravated, also, by any movement which tends to put the nerve on the stretch, as in bending down to put on the shoes, such movements also causing tingling down the nerve, and sometimes numbness in the foot. This may be demonstrated by flexing the thigh on the abdomen with the knee extended. There is no pain if the same manœuvre is repeated with the knee flexed. The nerve is sensitive to pressure, the most tender points being its emergence from the

sacro-sciatic foramen, the hollow between the trochanter and the ischial tuberosity, and where the external popliteal nerve winds round the neck of the fibula. The muscles of the thigh are often wasted and weak.

The clinical features vary a good deal in different cases, but the affection is often very obstinate, and may last for many weeks or even months.

In the sciatica which results from neuritis, there may be patches of cutaneous anæsthesia, loss of tendon reflexes, localised wasting of muscles, and vaso-motor and trophic changes. The presence of the reaction of degeneration confirms the diagnosis of neuritis. A diminution in the surface temperature of the limb is held by some to be pathognomonic. In long-standing cases, the pain and discomfort may lead to a postural scoliosis (*ischia scoliotica*).

*Diagnosis.*—Pain referred along the course of the sciatic nerve is a common symptom of tumours of the uterus, the rectum, or the pelvic bones. It may result also from the pressure of an abscess or an aneurysm either inside the pelvis or in the buttock, and is sometimes associated with organic disease of the spinal cord, such as tabes. Sciatica may also be mistaken for disease in the hip or sacro-iliac joints, especially tuberculous disease and arthritis deformans. It is necessary, therefore, to exclude such conditions before arriving at a diagnosis of sciatica. A digital examination of the rectum or vagina is often of great value in excluding intra-pelvic tumours.

*Treatment* is both general and local. Any constitutional tendency, such as gout or rheumatism, must be counteracted, and indigestion, oxaluria, and constipation must receive appropriate treatment. In acute cases the patient is confined to bed, the limb is wrapped up in wool, and the knee is flexed over a pillow. A rubber hot bottle may be applied over the seat of greatest pain. The bowels should be well opened by castor oil or by calomel followed by a saline. Salicylate of soda in full doses, or aspirin, usually proves effectual in relieving pain, but when this is very intense it may call for injections of morphin. Great benefit has been obtained from the injection into the nerve itself at its point of emergence from the sciatic foramen, of a 1 per cent. solution of $\beta$-eucaine in 8 per cent. saline solution. From 70-100 c.c. of the solution are injected at one time. If the pain recurs, a second injection is usually followed by its complete disappearance (Lange).

In the less severe cases the patient should be encouraged to move about and take regular exercise. Marked relief usually results from bathing, douching, and massage, and from repeated

gentle stretching of the nerve. This may be carried out by passive movements of the limb—the hip being flexed while the knee is kept extended; and by active movements—the patient flexing the limb at the hip while the leg is extended on the thigh. These exercises, which may be preceded by massage, are carried out night and morning, and should be practised systematically by those who are liable to sciatica.

In obstinate and severe cases *the nerve may be needled*, or it may be *forcibly stretched*. Needling or acupuncture of the sciatic consists in piercing the nerve at intervals in the buttock and down the back of the thigh with long steel needles. Six or eight needles are inserted and left in position for from fifteen to thirty minutes. The nerve may be stretched under anæsthesia by placing the patient on his back with the hip flexed to a right angle, and then gradually extending the knee until it is in a straight line with the thigh (Billroth). A more effectual method is to expose the nerve through an incision at the fold of the buttock, and forcibly pull upon it. Crawford Renton has pointed out that this operation is most successful when the nerve is involved in adhesions. The general regimen already described is also carried out during the after-treatment.

**Trigeminal Neuralgia.**—A severe form of epileptiform neuralgia occurs in one or more branches of the fifth nerve, and is one of the most painful affections with which we have to deal. So far as its pathology is known, it is believed to be associated with degenerative changes in the Gasserian ganglion. It is met with in adults, and develops without apparent cause; it is almost invariably unilateral. The pain, which occurs in paroxysms, is at first of moderate severity, but gradually becomes agonising. In the early stages the paroxysms occur at wide intervals, but later they recur with such frequency as to be almost continuous. They are usually excited by some trivial cause, such as opening the jaws in eating or speaking, touching the face as in washing, or by exposure to a draught of cold air. Between the paroxysms the patient is free from pain, but is in constant terror of its return, and the face wears an expression of extreme suffering and anxiety. When the paroxysm is accompanied by twitching of the facial muscles it is called *spasmodic tic*.

The skin of the affected area may be glazed and red, or may be pale and moist with inspissated sweat, the patient not daring to touch it.

There is excessive tenderness at the points of emergence of

the different branches of the fifth nerve on the face, and pressure over one or other of these points may excite a paroxysm of pain. The affection is but little amenable to the remedies employed in the treatment of other forms of neuralgia, and, as a rule, is only relieved by large doses of morphin or chloral. In typical cases the patient is unable to take any active part in life. The attempt to eat is attended with such severe pain that he avoids taking food. In some cases the suffering is so great that the patient only obtains sleep by the use of hypnotics, and he is often on the verge of committing suicide.

*Diagnosis.*—There is seldom any difficulty in recognising the disease. It is important, however, to exclude the hysterical form of neuralgia, which is characterised by its occurrence earlier in life, by the pain varying in situation, being frequently bilateral, and being more often constant than paroxysmal.

*Treatment.*—Before having recourse to the measures described below, it is necessary to give a thorough trial to such drugs as arsenic, quinine, and strychnine, and to employ the other medical measures used in the treatment of neuralgia.

*The Injection of Osmic Acid into the Nerve.*—Although the results of this procedure are uncertain, it may be had recourse to when operative interference is contra-indicated. Five to ten minims of a 1 per cent. solution are injected into the nerve and the tissues in its vicinity by means of an ordinary hypodermic syringe. The injection is immediately followed by severe pain, redness, and swelling, but after this subsides there may be no return of the neuralgia.

*Operative Treatment.*—This consists in the removal of the affected nerve or nerves as completely as possible, either by resection of the nerve—*neurectomy*; or by a combination of resection with twisting or tearing of the nerve from its central connections—*avulsion.* These procedures are fairly successful when the pain is limited to one or more branches of one of the main divisions of the fifth nerve.

The *supra-orbital* and *supra-trochlear* branches of the first division may be resected through an incision made in the line of the eyebrow.

The *infra-orbital* continuation of the second division may be resected by an operation in which the incision is made over the infra-orbital foramen, and the nerve is traced back along the canal in the floor of the orbit; or the main trunk may be removed at its emergence from the foramen rotundum along with Meckel's ganglion by resecting and temporarily displacing the malar bone.

The *inferior dental* is the branch of the third division most

frequently affected. It can be exposed before it enters the bone by trephining the ascending ramus of the lower jaw opposite the last molar tooth, and below, by cutting down on the nerve as it emerges from the mental foramen; the intervening portion is then pulled out from the inferior dental canal. The *lingual nerve* is also exposed lying in front of the inferior dental when the ascending ramus of the lower jaw is trephined. The *auriculo-temporal* branch can be exposed by a vertical incision crossing the zygoma immediately in front of the ear. The *entire trunk of the third division* may be exposed at the foramen ovale by an operation in which the zygoma and the masseter muscle are displaced downwards, the temporal muscle and coronoid process upwards, and the lingual and inferior dental branches are then traced upwards until the main trunk is reached at its emergence from the skull.

When the neuralgia involves branches of two or of all three divisions, or when it has recurred after temporary relief following resection of individual branches, the *removal of the Gasserian ganglion*, along with the main trunks of the second and third divisions, should be considered. This is usually carried out by what is known as the Krause-Hartley operation, which consists in making a large opening into the skull in the temporal region, stripping up the dura, and raising the temporo-sphenoidal lobe of the brain from the middle fossa of the skull until the ganglion is exposed lying on the upper aspect of the petrous temporal bone.

The operation is a difficult and serious one, but the results are satisfactory so far as the cure of the neuralgia is concerned. Krause reports twenty-seven cases with three deaths. There is little or no disability from the unilateral paralysis of the muscles of mastication; but on account of the insensitiveness of the cornea, the eye must be carefully protected from irritation, especially during the first month or two after the operation; this may be done by fixing a large watch-glass around the edge of the orbit with adhesive plaster.

In cases in which the removal of the Gasserian ganglion is contra-indicated, it may be worth while to *excise the superior ganglion of the cervical sympathetic*. The resulting vaso-motor disturbance may lead to the disappearance of the neuralgia, although this result may be delayed for several months, and cannot be relied upon.

# CHAPTER XVII.

## THE SKIN AND SUBCUTANEOUS TISSUE.

Structure of skin — *Blisters* — *Callosities* — *Corns* — *Chilblains* — *Boils* — *Carbuncle* — *Abscess* — *Veldt sores* — Tuberculosis of skin : *Inoculation tubercle* — *Lupus : Varieties* — Elephantiasis : *Varieties* — Sebaceous cysts or wens — Moles — Horns — New growths : *Fibroma ; Papilloma ; Adenoma ; Epithelioma ; Rodent cancer ; Melanotic cancer ; Sarcoma* — Affections of Cicatrices — *Varieties of scars* — *Keloid* — *Tumours* — Affections of Nails.

**Structure of Skin.**—The skin is composed of two layers, a superficial cellular layer—the epidermis, and the corium or true skin. The *epidermis* is differentiated from without inwards into the stratum corneum or horny layer, the stratum lucidum or clear layer, the stratum granulosum, and the rete Malpighii or germinal layer, from which all the others are developed. The deeper layer, known as the *corium or true skin*, consists of connective tissue, in which ramify the blood-vessels, lymphatics, and nerves. That part of the corium immediately adjoining the epidermis is known as the papillary portion, and contains the terminal loops of the cutaneous blood-vessels and the terminations of the cutaneous nerves. The deeper layer of the true skin is known as the reticular portion, and is largely composed of adipose tissue.

**Blisters** result from the exudation and accumulation of serous fluid beneath the horny layer of the epidermis. The fluid may be clear, as in the blister of a recent burn, or blood-stained, as in the blisters so commonly seen in severe fractures of the leg. It may become purulent as a result of the entrance of pyogenic organisms, and this may be the starting-point of septic lymphangitis, cellulitis, or lymphadenitis.

The *treatment* consists in disinfecting the skin and puncturing the blister to let out the fluid. When septic, the separated horny layer must be cut away with scissors in order to allow of the necessary disinfection.

**Callosities** are prominent, indurated masses of the overgrown horny layer of the epidermis where it has been exposed to

prolonged friction and pressure. They occur on the fingers and hand as a result of certain occupations and sports, but are most common under the balls of the toes or heel. A bursa may form beneath a callosity, and if it becomes inflamed may cause considerable suffering.

The *treatment* of callosities on the foot consists in removing pressure by wearing properly fitting boots, and in applying a ring pad around the callosity. In addition, after soaking in hot water, the overgrown horny layer may be pared away with a knife, and the part painted once daily with a saturated solution of salicylic acid in flexile collodion.

**Corns.**—A corn is a localised overgrowth of the horny layer of the epidermis which grows downwards, pressing upon and displacing the sensitive papillæ of the corium. Corns are due to the friction and pressure of ill-fitting boots, and are met with chiefly on the toes. A corn is usually hard, dry, and white; but it may be sodden from moisture, as in "soft corns" between the toes. A bursa may form beneath a corn, and if inflamed constitutes one form of bunion. When suppuration takes place in relation to a corn, it is very painful and disabling, and may prove the starting-point of lymphangitis. The suffering which attends ordinary corns varies with the weather and climate.

The *treatment* consists in the wearing of properly fitting boots and stockings, and in removing the corn. This is done after the manner of chiropodists by digging out the corn with a suitably shaped knife. A more radical procedure is to excise, under local anæsthesia, the portion of skin containing the corn and the underlying bursa if present. The majority of so-called corn solvents consist of a solution of salicylic acid in collodion; if this is painted on daily the epidermis dies and is thus more easily pared away. The unskilful paring of corns on the toes may determine the occurrence of senile gangrene in those who are predisposed to this disease by atheromatous arteries.

**Chilblains.** — Chilblain or *erythema pernio* is a vascular disturbance resulting from the alternate action of cold and heat on the distal parts of the body. Chilblains are met with chiefly on the fingers and toes in children and anæmic girls. In the mild forms there is a sensation of burning and itching, the part rapidly becomes swollen, of a dusky-red colour, and the skin tense and shiny. In more severe cases the burning and itching are attended with pain, and the skin becomes of a violet or wine-red colour. There is a third degree, closely approaching frost-bite, in which the skin tends to blister and give way, leaving an indolent raw surface popularly known as a "broken chilblain."

The *treatment* consists in improving the general health and the circulation by brisk open-air exercise, nourishing food, cod-liver oil, and tonics. Woollen stockings and gloves should be worn in cold weather, and sudden changes of temperature avoided. The symptoms may be relieved by ichthyol ointment, glycerin and belladonna, or a mixture of Venice turpentine, castor oil, and collodion applied on lint which is wrapped round the toe. To broken chilblains balsam of Peru or resin ointment spread on muslin should be applied.

**Boils and Carbuncles.**—These result from infection with the staphylococcus aureus, which enters the orifices of the ducts of the skin under the influence of friction and pressure, as was demonstrated by the well-known experiment of Garré, who produced a crop of pustules and boils on his own forearm by rubbing in a culture of the staphylococcus aureus.

A **Boil** results when the infection is located in a hair follicle or sebaceous gland. A hard, painful, conical swelling develops, to which, so long as the skin retains its normal appearance, the term "blind boil" is applied. Usually, however, the skin becomes red, and after a time breaks, giving exit to a drop or two of thick pus. After an interval of from six to ten days a soft white slough known as the "core" of the boil is discharged, consisting of the necrosed hair follicle or sebaceous gland. After the separation of the core the boil heals rapidly, leaving a small depressed scar.

Boils are most frequently met with on the back of the neck and on the buttocks, and on other parts where the skin is coarse and thick and is much exposed to friction and pressure. The occurrence of a number or a succession of boils is due to a spread of the original infection, the pus cocci from the original boil infecting adjacent hair follicles. The spread of boils may be unwittingly promoted by the use of a domestic poultice or the wearing of infected underclothing.

While boils are frequently met with in debilitated persons, such as those suffering from diabetes or Bright's disease, they also occur in those who enjoy vigorous health. They only prove dangerous to life when occurring in diabetic subjects. When they occur on the face there is a greater risk of lymphatic and general pyogenic infection. Boils may be differentiated from syphilitic lesions of the skin by their acute onset and progress, and by the absence of other evidence of syphilis; and from the malignant or anthrax pustule by the absence of the central black slough and of the circumstances which usually favour anthrax infection.

*Treatment.*—The local treatment consists in relieving the pain of the boil and in preventing the occurrence of others. The skin of the affected area should be sterilised as if for an operation.

A blind boil should be covered with Unna's mercury and carbolic plaster, or an ointment containing 20 per cent. oleate of mercury, and 5 per cent. carbolic acid should be rubbed into the skin over it. When boils tend to recur on the back of the neck this ointment should be rubbed into the skin every second night. In boils on the trunk and limbs, lysol or boracic baths are of great service; the underclothing should be frequently changed, and that which is discarded should be disinfected.

In a boil which is going on to suppuration the question of incision arises. As in other suppurative lesions, suffering is relieved by a timely incision and evacuation of the pus. The core is then removed with the sharp spoon, and the wound swabbed out with pure carbolic acid. On the other hand, warm carbolic fomentations may be applied until the boil bursts and the core separates. The further treatment consists in the use of diluted boracic or resin ointment.

Although constitutional treatment has no direct curative influence on boils, any impaired condition of health should be corrected. When there is sugar or albumen in the urine the conditions on which these depend must receive appropriate treatment.

**Carbuncle** is a spreading inflammation of the deeper layers of the skin attended with suppuration and sloughing. It may be looked upon as an aggregation of boils, and is characterised by a densely hard base and a brownish-red discoloration of the skin. A carbuncle is usually about the size of a crown piece, but it may continue to enlarge until it attains the size of a dinner-plate. The patient is decidedly ill and feverish, and the pain may be so severe as to prevent sleep. As time goes on several points of suppuration appear, and when these burst there are formed a number of openings in the skin giving it a cribriform appearance; these openings exude pus. The different openings ultimately fuse and a large adherent greyish-white slough is exposed. The separation of this slough is a tedious process, and the patient may become exhausted by pain, discharge, and septic absorption. When the slough is finally thrown off, a large deep gap is left which takes a long time to heal. A large carbuncle is a grave disease, especially in a weakly person, and in one suffering from diabetes or chronic alcoholism. In the majority of cases the patient is laid aside for several months. It is most common

in male adults over forty years of age, and is usually situated on the back between the shoulders. When it occurs on the face or anterior part of the neck it is especially dangerous, because of the greater risk of general infection and septicæmia.

A carbuncle is to be differentiated from a syphilitic gumma and from anthrax pustule.

*Treatment.*—Pain is to be relieved by full doses of opium or codein. Opium is specially indicated when sugar is present in the urine. The diet should be liberal and easily digested, and alcoholic and other stimulants may be of service in tiding the patient over the critical period of the disease. Locally, carbolic fomentations are employed until suppuration commences. If the patient is able to stand an operation, the best procedure is to excise the carbuncle, cutting all round it and down to the deep fascia, swabbing the wound with pure carbolic acid, and packing with gauze. The illness is thereby much shortened, suffering is relieved, and the risk of extension and general infection diminished. When the resulting wound becomes covered with healthy granulations, Thiersch grafts may be applied over it.

When excision is contra-indicated, the next best procedure is to make several incisions across the carbuncle in different directions so that the resulting wound presents a stellate appearance; to cut away the undermined skin, remove the slough, and rub pure carbolic acid into all the exposed tissues, and then pack with iodoform gauze or worsted.

In very feeble patients these operations are inadmissible, and treatment is restricted to applying antiseptic fomentations, unless the pain is unbearable, in which case, after freezing the skin, a simple incision may be made to relieve tension and allow of discharge.

**Acute Abscesses of the Skin and Subcutaneous Tissue in Young Children.**—In young infants, abscesses are not infrequently met with scattered over the trunk and limbs, and are probably the result of infection of the sebaceous glands from dirty underclothing. The abscesses should be opened, and the further spread of infection prevented by thorough cleansing of the skin and by the use of clean under-linen. Similar abscesses are met with on the scalp in association with eczema, impetigo, and pediculosis.

**Veldt Sores.**—These have become well known owing to their prevalence among the troops during the recent war in South Africa. The sore usually originates in an abrasion of the epidermis, such as a sun blister, the bite of an insect, or a small wound or scratch. A pustule forms and bursts, and a brownish-

yellow scab forms over it. When this is removed a raw surface or ulcer is left which has little tendency to heal. These sores are most common about the hands, arms, neck, and feet, and are most apt to occur in those who have had no opportunities of washing, and who have lived for a long period on tinned foods. The appearance of a number of white scars, each surrounded by a zone of pigmentation, is commonly observed in those who have suffered from veldt sores.

**Tuberculosis of the Skin.**—Interest attaches chiefly to the primary forms of tuberculosis of the skin in which the bacilli usually penetrate from without—inoculation tubercle and lupus.

The *secondary forms of tuberculosis of the skin* usually result from the rupture of cold abscesses which have originated from tuberculous disease of lymphatic glands, bones or joints. They are most often met with in the neck in association with disease in the glands, in the form of multiple tuberculous ulcers.

**Inoculation Tubercle.**—The appearances vary with the conditions under which the inoculation takes place. As observed on the fingers of adults, the affection takes the form of an indolent, painless swelling, the epidermis being red and glazed or warty and irregularly fissured. Sometimes the epidermis gives way, forming an ulcer with flabby granulations. The infection very rarely spreads to the lymphatics. In children who run about barefooted in towns, tubercle may be inoculated into accidental wounds in the sole or about the toes, and although the local appearances may not be characteristic, the nature of the infection is revealed by its tendency to spread up the limb along the lymphatic vessels, giving rise to enlargement, abscesses, and fungating ulcers in relation to the femoral glands.

The *treatment* consists in excising the infected sore and covering the resulting raw surface with a Thiersch graft. When this is impracticable the infected tissues are removed with the sharp spoon.

**Tuberculous Lupus.**—This is an extremely chronic affection of the skin. It very rarely extends to the lymphatic glands, and of all tuberculous lesions is the least dangerous to life. The commonest form of lupus—*lupus vulgaris*—usually commences in childhood or youth, and is most often met with on the nose or cheek. The early and typical appearance is that of brownish-yellow or pink nodules in the skin, about the size of a hemp seed. Their characters are best studied by examining them through a lens pressed firmly against the skin. The appearance of the contents of these nodules has been likened to apple jelly. Microscopical examination of the skin shows the

apple-jelly material to consist of aggregations of epithelioid and giant cells over which the epidermis is stretched and thinned. Tubercle bacilli are scanty and difficult to stain. The original nodules tend to fuse together, while fresh ones are formed at the margins. "The epidermis, as a result of surface irritation in which pus organisms play a prominent part, becomes the seat of a catarrhal process attended with a discharge of pus which dries up, forming yellowish-brown crusts or scabs, and the apple-jelly nodules are thereby concealed; when the scabs are removed what looks like a raw surface covered with pale granulation tissue is exposed" (Norman Walker). Healing frequently occurs in the centre of the affected area while the disease continues to extend at the margins.

When there is actual destruction of tissue and ulceration—the so-called "*lupus exedens*" or "*ulcerans*"—healing is attended with cicatricial contraction, which may cause unsightly deformity. When the cheek is affected the lower eyelid may be drawn down and everted; when the lips are affected the mouth may be distorted or seriously diminished in size. When the nose is affected, both the skin and mucous surfaces are usually involved, and the nasal orifices may be narrowed or even obliterated; sometimes the entire soft parts, including the cartilages, are destroyed, leaving only the bones covered by tightly stretched scar tissue.

The disease progresses very slowly, healing in some places and spreading at others. The patient complains of a burning sensation, but very little of pain, and is chiefly concerned about the disfigurement. Nothing is more characteristic of lupus than the appearance of fresh nodules in parts which have already healed. In the course of years large tracts of the face and neck may become affected. From the lips it may spread on to the gum and palate, giving to the mucous membrane the appearance of a raised, bright-red, papillary or villous surface. When the disease affects the gums the teeth may become loose and fall out.

On parts of the body other than the face the disease is even more chronic, and is often attended with a considerable production of dense fibrous tissue — the so-called *fibroid lupus*; there are very few tubercle nodules, and the disease has little tendency to destroy parts. Sometimes there is a warty thickening of the epidermis—*lupus verrucosus*. In the fingers and toes it may lead to a progressive destruction of tissue like that observed in certain forms of leprosy, and from the resulting loss of portions of the digits it has been called *lupus mutilans*. In the lower extremity a remarkable form of

the disease is sometimes met with, to which the term *lupus elephantiasis* has been applied. It usually commences as an ordinary lupus of the toes or dorsum of the foot, from which the tuberculous infection spreads to the lymphatic vessels, and the limb as a whole becomes enormously swollen and unshapely (Fig. 80).

Finally, a long-standing lupus, especially on the cheek, may become the seat of epithelioma—*lupus epithelioma*—usually of the exuberant or cauliflower type, which presents little tendency to infect the lymphatics.

The *diagnosis* of lupus is founded on the recognition of the apple-jelly nodules, on the chronic progress and long duration, and the central scarring with peripheral extension of the disease. On the face it is most liable to be confused with syphilis and with rodent cancer. The syphilitic lesion belongs to the tertiary period, and although presenting a superficial resemblance to tuberculosis its progress is much more rapid, so that within a few months it may involve an area of skin as wide as would be affected by lupus in as many years. Further, it readily yields to anti-syphilitic treatment. In cases of tertiary syphilis in which the nose is destroyed, it will be noticed that the bones have suffered most, whereas in lupus the destruction of tissue involves chiefly the soft parts of the tip of the nose.

Rodent cancer is very liable to be mistaken for lupus, because it may affect the same parts of the face, it is equally chronic, and may partially heal. It begins later in life, however, the margin of the ulcer is more sharply defined, and often presents a "rolled" appearance (Figs. 82 and 83).

The *treatment* of lupus varies with its situation, its extent, and the stage at which it is met. Although general treatment is indicated it is rarely curative, and local measures are required to eradicate what is after all a purely local disease.

Numerous methods are employed for the local treatment of lupus, and much difference of opinion exists as to the relative merits of these. When the disease is confined to a very limited area the most rapid and certain cure is obtained by *excision*. The whole thickness of skin is removed throughout and beyond the area affected; the edges of the gap are brought together by sutures, or the raw surface is covered with a Thiersch graft. On the covered parts of the body excision may be employed, even when the disease involves an extensive area.

When lupus covers a wide area of the face, as is more often the case in hospital practice, there is great difficulty in bringing about a cure. In recent years the therapeutic effects

obtained by exposure to different forms of rays have been employed with so much success in this group of cases that they have superseded the older methods. The *ray treatment* includes the use of luminous, Röntgen, or other rays, and possesses the advantage of being comparatively painless and of being followed by the least amount of scarring and deformity.

The light treatment, introduced by Finsen, of Copenhagen, consists in concentrating sunlight, or, in its absence, the electric arc light, by means of an apparatus which cuts off the heat rays, so that the blue, violet, and ultra-violet rays are allowed to act upon the diseased tissue. This is followed by an inflammatory reaction in the adjoining tissues, which results in the destruction of the tubercle bacilli. The disadvantage of the method is the small area which can be subjected to the rays at each exposure, so that the treatment is very prolonged; a large area may require hundreds of exposures.

The Röntgen-ray treatment consists in exposing the diseased area to the rays from a Crookes' tube of about six-inches spark, for ten or fifteen minutes daily, at a distance of from four to five inches from the tube. The healthy skin is protected by a sheet of lead foil, from which a piece is cut out corresponding to the diseased area. After a variable number of exposures inflammatory reaction takes place, and experience is required to control the effects within the desired limits. The duration of treatment is usually shorter than by the Finsen method, and the X-rays can be applied to larger areas and when there is ulceration, and also to lupus of mucous membranes.

The rays given off from radium have been found to have a similar curative influence on tuberculous lesions of the skin.

**Multiple subcutaneous tuberculous abscesses** are met with chiefly on the extremities of children. They are indolent and painless, and rarely attract attention until they break down and form abscesses, which are usually about the size of a cherry, and when these burst sinuses or ulcers result. If the overlying skin is still intact the best treatment is to excise the abscess. If the abscess has already infected the skin, each focus should be scraped, swabbed out with pure carbolic acid, and packed with gauze.

**Elephantiasis.**—This term is applied to an excessive enlargement of a part depending upon a widely spread overgrowth of the skin and subcutaneous cellular tissue, and resulting from a number of causes, acting independently or in combination. The condition is observed chiefly in the extremities and in the external organs of generation.

*Elephantiasis from Lymphatic or Venous Obstruction.*—Of this

the best-known example is *tropical elephantiasis* (E. arabum), which is endemic in Samoa, Barbadoes, and certain other places. It attacks the lower extremity or the external genitals in either sex (Fig. 79). The disease is usually ushered in with fever, and signs of inflammation, of the nature of lymphangitis, in the part affected. After a number of such attacks, the lymphatic vessels appear to become obliterated, and the skin and subcutaneous cellular tissue, being bathed in stagnant lymph—which

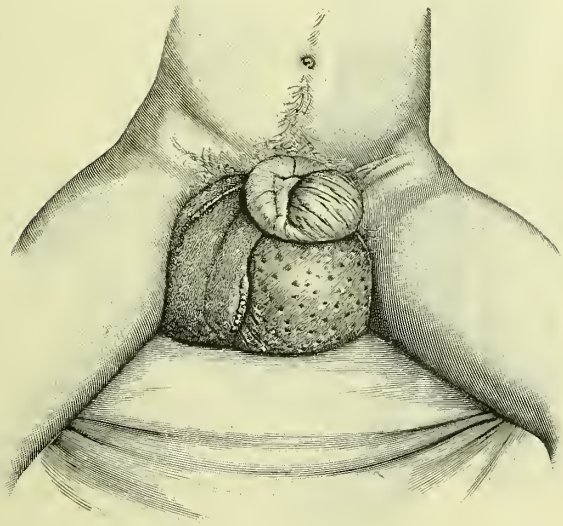


Fig. 79.—Elephantiasis of Penis and Scrotum in native of Demerara.

(Mr. Annandale's case.)

possibly contains the products of streptococci—take on an overgrowth, which continues until the part assumes gigantic proportions. In a certain number of cases the lymphatic trunks have been found to be blocked with the ova of the filaria sanguinis hominis or with the parent worms. It must be clearly understood, however, that cases of elephantiasis of the lower extremity are met with in this country in which there are no filarial parasites in the lymphatics. These cases present features indistinguishable from the tropical variety, and usually follow upon repeated attacks of lymphangitis or erysipelas.

The part affected with elephantiasis is enormously increased

in size, and causes inconvenience from its bulk and weight. In contrast to ordinary dropsy, there is no pitting on pressure. The skin tends to become rough and warty, and may hang down in pendulous folds. Blisters may form on the surface and yield an abundant exudate of clear lymph. From neglect of cleanliness, the skin may become the seat of eczema or even of ulceration attended with foul discharge.



Fig. 80.—Lupus Elephantiasis.
(Sir P. H. Watson's case.)

The *treatment* consists in maintaining an aseptic condition of the part, combating the inflammatory attacks, and reducing the swelling by elevation of the limb, massage, and the use of an elastic bandage. Removal of the overgrown tissues is commonly practised in elephantiasis of the external genitals; in the lower extremity, the excision of large wedge masses of tissue greatly reduces the bulk and weight of the limb.

A similar type of elephantiasis may occur in the upper or lower extremity after extirpation of all the lymphatic glands in the axilla or groin; in the leg in long-standing varix and phlebitis with chronic ulcer; in the arm as a result of extensive cancerous disease of the lymphatics; in the axilla secondarily to cancer of the breast; and in extensive tuberculous disease of the lymphatics. The last-named is chiefly observed in the lower limb in young adult women, and from its following upon lupus of the toes or foot it has been called *lupus elephantiasis* (Fig. 80). The tuberculous infection spreads very slowly up the limb by way of the lymphatics, and as these are obliterated the skin and cellular tissue become hypertrophied, and the surface studded over with fungating tuberculous masses of a livid-blue colour. As the disease may prove dangerous to life by septic complications inducing gangrene of the limb, the question of amputation may have to be considered.

Belonging to this group also is a form of congenital elephantiasis resulting from the circular constriction of a limb *in utero* by amniotic bands.

*Elephantiasis occurring apart from lymphatic or venous obstruction* is illustrated by *elephantiasis nervorum*, in which there is an overgrowth of the skin and cellular tissue of an entire extremity in association with neuro-fibromatosis of the cutaneous nerves; and by *elephantiasis Græcorum*—a form of leprosy in which the skin of the face becomes the seat of tumour-like masses consisting of leprous nodules. It is also illustrated by *elephantiasis involving the scrotum* as a result of the prolonged irritation of the urine in cases in which the penis

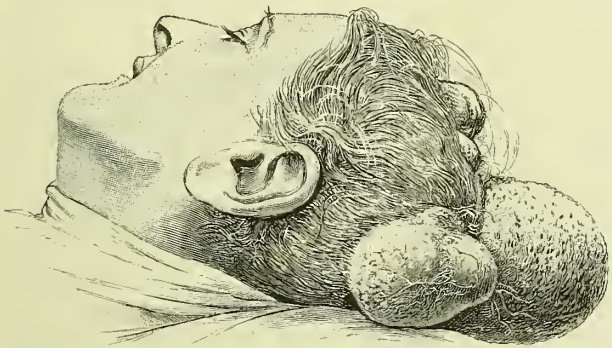


FIG. 81.—Multiple Sebaceous Cysts or Wens; the larger ones are of many years' duration.

has been amputated and the urine has infiltrated the scrotal tissues.

**Sebaceous Cysts.**—Atheromatous cysts or wens are retention cysts formed in relation to the sebaceous glands and hair follicles. They are commonly met with in adults, on the scalp (Fig. 81), face, neck, back, and external genitals. Sometimes they are multiple, and they may be met with in several members of the same family. They are smooth, rounded or discoid cysts, varying in size from a split-pea to a tangerine orange. In consistence they are firm and elastic, or fluctuating, and are incorporated with the overlying skin, but movable on the deeper structures. The orifice of the partially blocked sebaceous follicle may be visible (except on the scalp), and some of the contents of the cyst can be squeezed through the opening. The wall of the cyst is composed of a connective-tissue capsule lined by stratified

squamous epithelium. The contents consist of accumulated epithelial cells, and are at first dry, and pearly white in appearance, but as a result of fatty degeneration they break down into a greyish-yellow pultaceous and semi-fluid material having a peculiar stale odour. It is probable that the decomposition of the cyst contents is the result of the presence of bacteria, and that from the surgical point of view they should be regarded as infective. A sebaceous cyst may remain indefinitely without change, or may slowly increase in size, the skin over it becoming stretched and closely adherent to the cyst wall as a result of friction and pressure. The contents may become calcareous or may ooze from the orifice of the duct and dry on the skin surface, leading to the formation of a sebaceous horn. As a result of injury the cyst may undergo sudden enlargement from hæmorrhage into its interior.

Recurrent attacks of inflammation frequently occur, especially in wens of the face and scalp. Suppuration may ensue and be followed by cure of the cyst, or an offensive fungating ulcer results which may be mistaken for epithelioma. True cancerous transformation is very rare.

Wens are to be *diagnosed* from dermoids, from fatty tumours, and from cold abscesses. Dermoids usually appear before adult life, and as they nearly always lie beneath the fascia the skin is movable over them. A fatty tumour is more movable, and is often lobulated. The confusion with a cold abscess is most likely to occur in wens of the neck or back, and it may be impossible without operation to differentiate between them.

*Treatment.*—The removal of wens is to be recommended while they are still small and freely movable, as they are then easily shelled out after incising the overlying skin. Local anæsthesia is to be preferred. It is important that none of the cyst wall be left behind. In large and adherent wens an ellipse of skin should be removed along with the cyst. When inflamed, the cyst wall must be destroyed with pure carbolic acid, the resulting wound being treated by the open method.

**Moles.**—The term mole is applied to a pigmented, and usually hairy, patch of the skin, present at or appearing shortly after birth. The colour varies from brown to black according to the amount of melanin pigment present. The essential lesion consists in an overgrowth of epidermis continuous with that on the surface, and often presenting an alveolar arrangement. Moles vary greatly in size: some are mere dots, others are as large as the palm of the hand, and occasionally a mole covers half the face or trunk. In addition to being unsightly, they

bleed freely when abraded, are liable to ulcerate from friction and pressure, and occasionally become the starting-point of melanotic cancer. Rodent cancer sometimes originates in the slightly pigmented moles met with on the face. Overgrowths in relation to the cutaneous nerves, especially the plexiform neuroma, occasionally originate in pigmented moles. Soldau believes that the pigmentation and overgrowth of the epidermis in moles are associated with, and probably result from, a fibromatosis of the cutaneous nerves.

*Treatment.*—The best way to get rid of a mole is to excise it. If the edges of the gap cannot be brought together with sutures, recourse should be had to Thiersch grafting. In large hairy moles of the face whose size forbids excision, the hairs may be got rid of by the Röntgen rays.

**Horns.**—Four varieties of cutaneous horn are described by Bland Sutton. The *sebaceous* horn results from the accumulation of the dried contents of a wen on the surface of the skin. The sebaceous material after drying up becomes cornified, and as fresh material is added to the base the horn increases in length. The *wart* horn grows from a warty papilloma of the skin. *Cicatrix* horns are sometimes formed by the heaping up of epidermis in the scars which result from burns. *Nail* horns are overgrown nails (keratomata of the nail-bed), and are met with chiefly in the great toe of elderly bedridden patients. If an ulcer forms at the base of a horn it may prove the starting-point of epithelioma. On this and other grounds it is better to remove horns.

**New Growths in the Skin and Subcutaneous Tissue.**—*Fibroma.*—Various types of fibroma are met with in the skin. Soft pedunculated fibromata, about the size of a pea, are very commonly met with, especially on the neck and trunk; they are usually solitary, and are of no clinical importance. The multiple soft fibromata, known as *molluscum fibrosum*, which depend upon a neuro-fibromatosis of the cutaneous nerves, are described with the tumours of nerves (p. 342). Hard fibromata occurring singly or in groups may be met with, especially in the skin of the buttock, and may present a local malignancy, recurring after removal like the "recurrent fibroid" of Paget. The "painful subcutaneous nodule" is a solitary fibroma related to one of the cutaneous nerves. The hard fibroma known as keloid is described with the affections of scars (p. 375).

**Papilloma.**—The *common wart* or verruca is an outgrowth of the surface epidermis. It may be sessile or pedunculated, hard or soft. The surface may be smooth, or fissured and foliated

like a cauliflower, or it may be divided up into a number of spines. Warts are met with chiefly on the hands and face, and are often multiple, occurring in clusters or in successive crops. Multiple warts appear to result from some contagion, the nature of which is unknown; they sometimes occur in an epidemic form among school children, and show a remarkable tendency to disappear spontaneously. The solitary flat-topped wart which occurs on the face of old people may, if irritated, become the seat of epithelioma.

*Treatment.*—In the multiple warts of children the health should be braced up by a change to the seaside. A dusting powder, consisting of boracic acid with five per cent. salicylic acid, may be rubbed into the hands after washing and drying. The persistent warts of young adults are best removed with scissors after freezing with chloride of ethyl. When cutting is objected to they should be painted night and morning with salicylic collodion, the epidermis being dehydrated with alcohol before each application.

*Venereal warts* occur on the genitals of either sex, and may form large cauliflower-like masses on the inner surface of the prepuce or of the labia majora (Fig. 47). Although frequently coexisting with gonorrhœa or syphilis, they may occur independently of these diseases, being probably acquired by contact with another individual suffering from warts (C. W. Cathcart). They give rise to considerable irritation and suffering, and when cleanliness is neglected they may be attended with an offensive discharge.

In advanced cases with large cauliflower-like masses, it is best to remove them. In the female, they are dissected off from the labia; in the male, the prepuce is removed and the warts on the glans are snipped off with scissors. In milder cases, the warts usually disappear if the parts are kept absolutely dry and clean. A useful dusting-powder is one consisting of calamine and five per cent. salicylic acid. The exsiccated sulphate of iron may be employed in cases which resist this treatment.

Lastly, a warty growth of the epidermis may be an accompaniment of lupus—lupus verrucosus—and of moles.

**Adenoma.**—This is a comparatively rare innocent tumour growing from the glands of the skin. One variety, known as the "tomato tumour," which apparently originates from *the sweat glands*, is met with chiefly on the scalp and face in women past middle life. These growths are often multiple; the individual tumours vary in size, and the skin, which is almost devoid of hairs, is glistening and tightly stretched over them. A similar tumour

may occur on the nose. The *sebaceous adenoma*, which originates from the sebaceous glands, forms a projecting tumour on the face or scalp, and when the skin is irritated it may ulcerate and fungate (Fig. 48). The treatment consists in the removal of the tumour along with the overlying skin.

The exuberant masses on the nose known as "lipoma nasi" or "potato-nose" are of the nature of sebaceous adenomata, and are removed by shaving them off with a knife until the normal shape of the nose is restored. Healing takes place with remarkable rapidity.

**Cancer.**—There are several types of primary cancer of the skin, the most important being squamous epithelioma, rodent cancer, and melanotic cancer.

**Epithelioma** occurs in a variety of forms. When originating in a small ulcer or wart—for example, in the skin of the face in old people—it presents the features of a chronic indurated ulcer. A more exuberant and rapidly growing form of epithelial cancer has been described by Hutchinson as the *crateriform ulcer*. This commences on the face as a small red pimple which rapidly develops into an elevated mass shaped like a bee-hive and breaks down in the centre. Epithelioma may develop anywhere on the body in relation to scar tissue, especially that resulting from burns or lupus. This form usually presents an exuberant outgrowth of epidermis not unlike a cauliflower wart. Mention should also be made of the paraffin-worker's, chimney-sweep's, and other forms of what may be called trade epithelioma, and of arsenic cancer occasionally observed in those who have taken large doses of arsenic for medicinal purposes over long periods.

**Rodent Cancer** (Rodent Ulcer).—This is a true cancer originating in the sweat glands or sebaceous follicles, or in the fœtal residues of cutaneous glands. The cells are small and closely packed together in alveoli or in reticulated columns. Cell nests are very rare. It is remarkably constant in its seat of origin, being nearly always located on the lateral aspect of the nose or in the vicinity of the lower eyelid (Figs. 82, 83). It is extremely rare on the trunk or limbs. It nearly always commences as a small flattened nodule in the skin, the epidermis over it being stretched and shining. The centre tends to become depressed, while the margin extends in the form of an elevated ridge. Sooner or later ulceration takes place in the centre, and the epidermis gives way, exposing a smooth raw surface devoid of granulations. The margin, while in parts irregular and ill-defined, is typically represented by a well-

defined "rolled" border which consists of the peripheral portion of the cancer that has not yet broken down. The central ulcer may temporarily scar over. There is itching but very little pain, and the condition progresses extremely slowly, so that rodent cancers which have existed for many years are frequently met with. It attacks and destroys every structure with which it comes in contact, such as the eyelids, the walls of the nasal cavities, and the bones of the face; hence it may produce the most hideous deformities (Fig. 84). The patient may succumb to hæmorrhage or to septic complications such as erysipelas or meningitis.



FIG. 82.—Advanced Rodent Cancer.

(Mr. Annandale's case.)

Secondary growths in the lymphatic glands, while not unknown, are extremely rare. We have only seen them once—in a case of rodent cancer in the groin.

*Diagnosis.*—Lupus is the disease most often mistaken for rodent cancer. Lupus vulgaris usually begins earlier in life, it presents the apple-jelly nodules, and it lacks the rounded, elevated border. Syphilitic lesions progress more rapidly and also lack the characteristic margin. The differentiation from squamous epithelioma is not as a rule difficult, but is of



FIG. 83.—Rodent Cancer of Inner Canthus.

considerable importance, as the latter affection, from its tendency to spread by the lymphatics, is much more dangerous to life.

*Treatment.*—In rodent cancers of limited size—say less than one inch in diameter—free excision is the most rapid and certain method of treatment. The alternative is the application of the Röntgen rays, which, although requiring many exposures over a period of weeks or months, results in cure with the minimum of disfigurement. If the cancer already covers an extensive area of the face, or has invaded the cavity of the orbit or nose, the Röntgen rays again yield the best results. The effect of the Röntgen rays is soon shown by the ingrowth of healthy epithelium from the surrounding skin, so that healing is promoted, and at the same time the pain and discharge are much lessened.

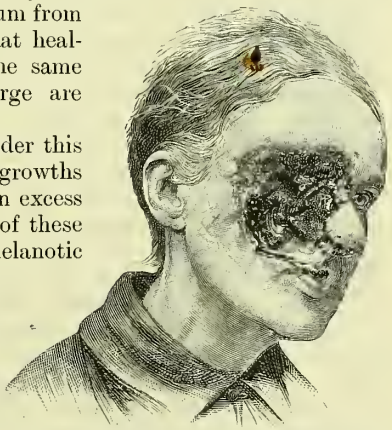


Fig. 84.—Rodent Cancer of fifteen years' duration, which has destroyed contents of Orbit.

(Mr. J. M. Cotterill's case.)

**Melanotic Cancer.**—Under this head are included all new growths of the skin which contain an excess of melanin pigment. Many of these were formerly described as melanotic sarcoma. They nearly always originate in a pigmented mole which has been subjected to irritation. The primary growth may remain so small that its presence is not even suspected, or it may increase in size, ulcerate, and fungate through the skin. The amount of pigment varies: when small in amount the growth is brown, when abundant it is a deep black. The most remarkable feature is the rapidity with which the disease becomes disseminated along the lymphatics, the first evidence of which is an enlargement of the lymphatic glands. As the primary growth is often situated on the sole of the foot (Fig. 85) or in the matrix of the nail of the great toe, the femoral and inguinal glands become enlarged in succession, forming tumours much larger than the primary growth. Sometimes the dissemination involves the lymphatic vessels of the limb, forming a series of indurated pigmented cords and nodules (Fig. 86). Lastly, the dissemination may be universal throughout the body, and this usually occurs at a comparatively

early stage in the disease, although it has been delayed in some cases for several years. The secondary growths are deeply pigmented, being usually of a coal-black colour, and melanin pigment may be present in the urine.

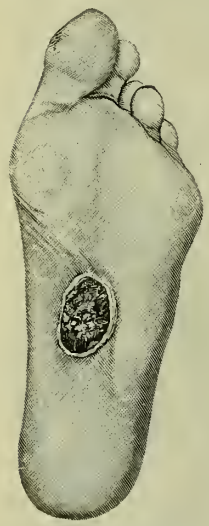


Fig. 85. — Melanotic Cancer of Sole of Foot.

The *treatment* consists in early and free removal of the primary growth, and of the associated lymphatic glands—whether these are enlarged or not. In the great majority of cases, when seen by the surgeon the disease is so far advanced that operative treatment holds out but little prospect of saving life.

**Secondary Cancer of the Skin.**—Cancer may spread to the skin from a subjacent growth by direct continuity or by way of the lymphatics. Both of these processes are well illustrated in cases of mammary cancer, and will be described along with diseases of the breast.

**Sarcomata** of various types are met with in the skin. The most common is the alveolar sarcoma, which commences as a hard lump and steadily increases in size until the epidermis gives way and an ulcer is formed. A number of fresh tumours may spring up around the original growth. Sometimes the primary appearance is in the form of multiple nodules in the skin which tend to become confluent. Excision, unless performed early, is of little avail.

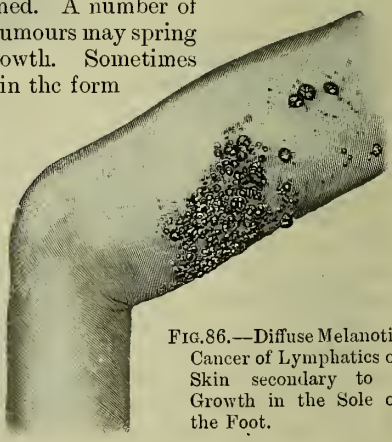


Fig. 86.—Diffuse Melanotic Cancer of Lymphatics of Skin secondary to a Growth in the Sole of the Foot.

### Affections of Cicatrices.

A cicatrix or scar consists of closely packed bundles of white fibres covered by epidermis; the skin glands and hair follicles are usually absent. The size, shape, and level of the cicatrix depend upon the conditions which preceded healing.

A healthy scar, when recently formed, has a smooth, glossy surface of a pinkish colour, which tends to become whiter as a result of obliteration of the blood-vessels concerned in its formation.

*Weak Scars.*—A scar is said to be weak when it readily breaks down as a result of irritation or pressure. The scars resulting from severe burns are especially liable to break down from trivial causes. The best treatment is to excise the weak portion of the scar and to cover the raw surface with Thiersch grafts.

*Contracted scars* frequently cause deformity either by displacing parts, such as the eyelid or lip, or by fixing parts and preventing the normal movements—for example, a scar on the flexor aspect of a joint (Fig. 55). These are treated by dividing the scar, correcting the deformity, and filling up the gap with Thiersch grafts. When deformity results from *depression of a scar*, as is not uncommon after the healing of a deeply seated abscess or sinus, the best treatment is to excise the scar and bring the edges of the gap together. Another method of elevating depressed scars is by the injection into the subcutaneous tissues of sterilised paraffin.

*Painful Scars.*—Pain in relation to a scar is usually due to the implication of nerves in the cicatricial tissue; the nerve fibres are compressed or stretched, and in some cases an ascending neuritis results. The treatment consists in excising the scar or in stretching or excising a portion of the nerve affected.

*Pigmented or Discoloured Scars.*—The best-known examples are the blue coloration which results from coal-dust or gunpowder, the brown scars resulting from chronic ulcer with venous congestion of the leg, and the variously coloured scars caused by tattooing. The only satisfactory method of getting rid of the coloration is to excise the scar; the edges are brought together by sutures, or the raw surface covered with Thiersch grafts according to the size of the gap.

*Hypertrophied Scars.*—Scars occasionally broaden out and become prominent, and this may prove a source of disappointment after operations, such as those for goitre or tuberculous glands in the neck.

*Keloid.*—This term is applied to an overgrowth of scar tissue which extends beyond the area of the original wound, and the name is derived from the fact that this extension usually occurs in the form of radiating processes, suggesting the claws of a crab. It is essentially a fibroma or new growth of

fibrous tissue, which commences in relation to the walls of the smaller blood-vessels; the bundles of fibrous tissue are for the most part parallel with the surface, and the epidermis is tightly stretched over them. There would appear to be an inherited predisposition to keloid. It is more frequent in the negro and in those who are, or have been, the subjects of tuberculous disease.

Keloid may attack scars of the most diverse nature, such as those resulting from leech-bites, acne pustules, boils or blisters; those resulting from operation or accidental wounds, and the scars resulting from burns, especially when situated over the sternum, are said to be specially liable. The scar becomes more and more conspicuous, is elevated above the surface, of a pinkish or brownish-pink colour, and sends out irregular prolongations around its margins. The patient may complain of itching and burning, and of great sensitiveness of the scar, even to contact with the clothing.

*Treatment.*—There is a natural hesitation to excise keloid because of the fear of its returning in the new scar. Such return, however, is very unlikely if it is excised widely and the raw surface covered over with Thiersch grafts. The irritation associated with keloid may be relieved by the application of salicylic collodion or of salicylic and creosote plaster.

*Epithelioma* is liable to attack weak scars in persons who have reached the cancerous age, and has been observed in old people in the scar of a burn sustained in early childhood. As a result of the absence of lymphatics in scar tissue, the disease is not disseminated by the lymphatics until it has invaded the tissues outside the scar area. It should be excised widely; in the extremities it may be best to amputate the limb.

## Affections of the Nails.

*Injuries.*—When a nail is contused or crushed, blood is extravasated beneath it, and the nail is usually shed, a new one growing in its place. A splinter driven underneath the nail causes great pain, and if organisms are carried in along with it, may give rise to septic complications. The free edge of the nail should be clipped away to allow of the removal of the foreign body and of the necessary disinfection.

*Trophic Changes.*—The growth of the nails may be interfered with in any disturbance of the general health. In nerve lesions, such as division of the nerve-trunks of a limb, the nails are apt to suffer along with the skin, becoming curved, brittle, or furrowed, or they may be shed.

*Onychia* is the term applied to inflammation of the soft parts around the nail or of the matrix beneath it. The commonest form of onychia is that resulting from septic infection, which has already been referred to under "Whitlow." There is a superficial variety resulting from the extension beneath the nail of a purulent blister, lifting it up from its bed, and the pus is visible through the nail. The nail should be removed as well as the raised horny layer of the epidermis. A deeper and more troublesome onychia results from infection at the nail fold; the infection spreads very slowly beneath the fold until it reaches the matrix, and a drop or two of pus forms beneath the nail, usually in the region of the lunule. This affection entails a disability of the finger which may last for many weeks unless it is properly treated. The nail fold and lunule should be frozen and a considerable portion removed with the knife; if only a small portion of the nail is removed, the opening is blocked by granulations springing from the matrix. A new nail is formed.

*Tuberculous onychia* (O. maligna) is met with chiefly in children and adolescents. It appears as a livid or red swelling at the root of the nail, spreading around its margins. The epidermis, which is thin and shiny, gives way, exposing a weak ulcer, and the nail is usually shed. The treatment is the same as in other tuberculous lesions.

*Syphilitic* affections of the nails assume various aspects. A primary chancre at the edge of the nail may be mistaken for a whitlow, especially if it is attended with much pain. Other forms of onychia occur during secondary syphilis, simultaneously with the skin eruptions, and may prove very obstinate and lead to shedding of the nails. The nails are often markedly affected in inherited syphilis. In addition to general treatment, an ointment containing five per cent. of oleate of mercury should be applied locally and the patient should wear gloves.

*Ingrowing Toe-nail* (lateral onychia).—This is more accurately described as an overgrowth of the soft tissues along the edge of the nail. It is most frequently met with in the great toe in young adults whose feet perspire freely, who wear ill-fitting shoes, and who cut their toe-nails carelessly or tear them with their fingers. Where the soft tissues are pressed against the edge of the nail, the skin gives way and there is the formation of exuberant granulations and of discharge which is sometimes fœtid. The affection is a painful one and may unfit the patient for work. In mild cases the condition may be remedied by getting rid of contributing causes and by disinfecting the skin

and nail. The nail is then cut in an even circle, and the groove between it and the skin is packed with an antiseptic dusting-powder, such as boracic acid. In more severe cases it may be necessary to remove one-half of the affected nail.

*Subungual exostosis* is an osteoma growing from the terminal phalanx of the great toe (Fig. 87). It raises the nail, and may

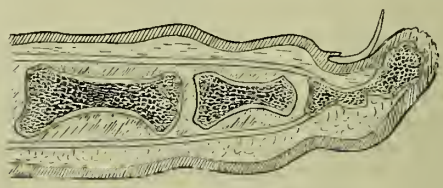


Fig. 87.—Subungual Exostosis growing from Distal Phalanx of Great Toe, showing Ulceration of Skin and Displacement of Nail.

be accompanied by ulceration of the skin over the most prominent part of the growth. The soft parts, including the nail, should be reflected towards the dorsum in the form of a flap and the tumour removed with the chisel.

*Malignant disease* in relation to the nails is very rare. Squamous epithelioma and melanotic cancer are the forms met with. Treatment consists in amputating the digit concerned, and in removing the associated lymphatic glands.

# CHAPTER XVIII.

## THE MUSCLES, TENDONS, AND TENDON SHEATHS.

INJURIES: *Contusion; Sprain; Rupture*—Hernia of muscle—Dislocation of tendons—Wounds—Avulsion of tendon. DISEASES OF MUSCLE AND OF TENDONS: *Atrophy; "Muscular rheumatism"; Contracture; Myositis; Ossification; Tumours.* DISEASES OF TENDON SHEATHS: *Teno-synovitis.*

### INJURIES.

**Contusion of Muscle.**—Contusion of muscle, which consists in rupture of its fibres and of blood-vessels, may be due to violence acting from without, as in blows, kicks, or falls; or from within, as by the displacement of a bone in fractures and dislocations.

The symptoms are those common to all contusions. The patient complains of severe pain on attempting to use the injured muscle, and maintains an attitude which will relax it. There is subcutaneous ecchymosis if the sheath of the muscle also is torn, and the accumulation of blood may result in the formation of a hæmatoma.

Restoration of function is usually complete; but when the nerve supplying the muscle is bruised at the same time, as is frequently the case in the deltoid, wasting and loss of function may be very persistent. In exceptional cases the process of repair may be attended with the formation of bone in the substance of the muscle (p. 387).

A contused muscle should be placed at rest and supported by cotton wool and a bandage—followed, after an interval, by massage, the use of the continuous current, and appropriate exercises.

**Sprain of Muscle.**—This lesion consists in overstretching and partial rupture of the fibres of a muscle or its aponeurosis. It is of common occurrence in athletes and in those who follow

laborious occupations. It may follow upon a single or on repeated efforts—especially in those who are out of training. Familiar examples of muscular sprain are the "labourer's" or "golfer's back," affecting the latissimus dorsi or erector spinæ; the "tennis-player's elbow," affecting the pronator radii teres; the "angler's elbow," affecting the common origin of the extensors and supinators; the "sprinter's sprain," affecting the flexors of the hip; and the "jumper's sprain," affecting the muscles of the calf. The patient complains of pain, often sudden in onset, of tenderness on pressure, and of inability to carry out the particular movement by which the sprain was produced. The disability varies in different cases, and it may incapacitate the patient from following his occupation or sport for weeks or even months.

The *treatment* consists in resting the muscle from the particular effort concerned in the production of the sprain, in gently exercising it in other directions, and in the use of massage.

**Rupture of Muscle or Tendon.**—A muscle or a tendon may be ruptured in its continuity or torn from its attachment to bone. The site of rupture in individual muscles is remarkably constant, and is usually at the junction of the muscle with its tendon. When rupture takes place through the belly of a muscle the ends retract, the amount of retraction depending on the length of the muscle between its points of attachment, and the extent of its attachment to adjacent aponeurosis or bone. The biceps in the arm, and the sartorius in the thigh, furnish examples of muscles in which the separation between the ends may be considerable.

The gap in the muscle becomes filled with blood, and this in time is replaced by connective tissue, which forms a bond of union between the ends. When the space is considerable the connecting medium consists of fibrous tissue, but when the ends are approximated it contains a number of newly formed muscle fibres. In the process of repair, one or both ends of the muscle or tendon may become fixed by adhesions to adjacent structures, and if the distal portion of a muscle is deprived of its nerve supply it may undergo degeneration and so have its function interfered with.

Rupture of a muscle or tendon is usually the result of a sudden, and often involuntary, movement. As examples may be cited the rupture of the quadriceps extensor in attempting to regain the balance when falling; of the gastrocnemius, plantaris, or tendo Achillis in jumping or dancing; of the adductors of the thigh in gripping a horse when it swerves; of the abdominal muscles in vomiting, and of the biceps flexor cubiti in sudden

movements of the arm. Sometimes the effort is one that would scarcely be thought likely to rupture a muscle, as in the case recorded by Pagenstecher, where a professional athlete, while sitting at table, ruptured his biceps in a sudden effort to catch a falling glass. It would appear that the rupture is brought about not so much by the contraction of the muscle concerned, as by the contraction of the antagonistic muscles taking place before that of the muscle which undergoes rupture is completed. The violent muscular contractions of epilepsy, tetanus, or delirium rarely cause rupture.

The *clinical features* are usually characteristic. The patient experiences a sudden pain, with a sensation of being struck with a whip, and of something giving way; sometimes a distinct snap is heard. The limb becomes powerless. At the seat of rupture there is tenderness and swelling, and there may be ecchymosis. As the swelling subsides a gap may be felt between the retracted ends, and this becomes wider when the muscle is thrown into contraction. If untreated, a hard, fibrous cord may be felt at the seat of rupture.

*Treatment.*—The ends are approximated by placing the limb in an attitude which relaxes the muscle, and the position is maintained by bandages, splints, or special apparatus. Where it is impossible thus to approximate the ends satisfactorily, the muscle or tendon is exposed by incision, and the ends brought into accurate contact by catgut sutures. This operation of primary suture yields the most satisfactory results and is most successful when it is done within five or six days of the accident. Secondary suture after an interval of months is rendered difficult by the retraction of the ends and by their adhesion to adjacent structures.

*Rupture of the biceps of the arm* may involve the long or the short head, or the belly of the muscle. Most interest attaches to rupture of the long tendon of origin. There is pain and tenderness in front of the humerus, the patient is unable to abduct or to elevate the arm, and he may be unable to flex the elbow when the forearm is supinated. The long axis of the muscle, instead of being parallel with the humerus, inclines downwards and outwards. When the patient is asked to contract the muscle, its belly is seen to be displaced towards the elbow.

The *quadriceps extensor femoris* is usually ruptured close to its insertion into the patella, in the attempt to save one's self from falling backwards. The injury is sometimes bilateral. The injured limb is rendered useless for progression, as it

suddenly gives way on flexion at the knee. Treatment is conducted on the same lines as in transverse fracture of the patella ; in the majority of cases the continuity of the quadriceps should be re-established by suture within five or six days of the accident.

The *tendo Achillis* is comparatively easily ruptured, and the symptoms are sometimes so slight that the nature of the injury may be overlooked. The limb should be put up with the knee flexed and the toes pointed. This may be effected by attaching one end of an elastic band to the heel of a slipper, and securing the other end to the lower third of the thigh. If this is not successful, the ends should be approximated by sutures.

The *plantaris* is not infrequently ruptured from trivial causes, such as a sudden movement in boxing or playing lawn tennis. A sharp stinging pain is felt in the calf, like the stroke of a whip. There is marked tenderness at the seat of rupture, and the patient is unable to contract the tendo Achillis without pain. The injury is of little importance, and if the patient keeps the heel to the ground in walking, it is recovered from in a couple of weeks or so.

*Partial rupture of muscle* is produced in the same way, and affects the same muscles, as complete rupture. There is pain and tenderness increased by movement, and there may be an appreciable gap in the continuity of the muscle, which, however, does not show the same tendency to increase when the muscle contracts as it does when the rupture is complete. The treatment consists in rest and massage, followed by movements and exercises calculated to restore the functions of the muscle.

**Hernia of Muscle.**—This is a rare condition, in which, owing to the fascia covering a muscle becoming stretched or torn, the muscular substance is protruded through the rent. It has been observed chiefly in the adductor longus. An oval swelling forms in the upper part of the thigh, is soft and prominent when the muscle is relaxed, less prominent when it is passively extended, and small and hard when the muscle is thrown into contraction. It is liable to be mistaken, according to its situation, for a tumour, a cyst, a pouched vein, or a femoral or obturator hernia. If there are no symptoms, no treatment is called for. If it is causing inconvenience, the muscle is exposed by a suitable incision, the herniated portion excised, and the rent in the sheath closed by sutures.

**Dislocation of Tendons.**—Tendons which run in grooves may be displaced as a result of rupture of the confining sheath.

This injury is met with chiefly in relation to the tendons at the ankle and in the long tendon of the biceps.

Dislocation of the *peronei tendons* may be met with—for example, in a patient who has recently sustained a violent twist of the foot. There is severe pain and considerable swelling in the region of the outer ankle; the peroneus longus by itself, or together with the brevis, is found lying on the outer aspect or in front of the external malleolus; the patient is unable to move the foot. By a little manipulation the tendons are replaced in their grooves, and are retained there by a series of strips of plaster. At the end of three weeks massage and exercises are employed.

Sometimes the displacement occurs apart from any known injury. Whenever the foot is everted the tendon of the peroneus longus is liable to be jerked forwards out of its groove, sometimes with an audible snap. The patient suffers pain and is disabled until the tendon is replaced. Reduction is easy, but the displacement tends to recur at intervals. Under these conditions an incision should be made over the tendon; if the sheath is slack or torn, it is tightened up or closed with catgut sutures; or an artificial sheath is made by raising up a quadrilateral flap of periosteum from the outer aspect of the fibula, and stitching it over the tendon.

Similarly the *tibialis posticus* may be displaced over the internal malleolus as a result of inversion of the foot.

The *long tendon of the biceps* may be dislocated outwards or inwards—usually inwards—as a result of violent or of repeated rotation movements of the upper arm, such as are performed in wringing clothes. The patient is aware of the displacement taking place, and is unable to extend the forearm until the displaced tendon has been reduced by abducting the arm. In recurrent cases, the patient may be able to dislocate the tendon at will, and in such cases the disability is so inconsiderable that there is rarely any occasion for interference.

**Wounds of Muscles and Tendons.**—Accidentally inflicted wounds of muscles are to be treated on the same lines as wounds of other soft structures, the muscle fibres being brought together with chromic gut sutures. If the ends are allowed to retract and if the wound suppurates, they are united by scar tissue and may become fixed to bone or other adjacent structures. In a limb this may interfere with the functions of the muscle: in the abdominal wall the scar tissue may stretch and yield, and so favour the development of a ventral hernia.

Tendons may be cut across accidentally, especially in those

wounds so commonly met with above the wrist as a result of the hand being thrust through a pane of glass. It is essential that the ends should be carefully sutured to each other, and as the upper end is retracted the original wound may require to be enlarged in an upward direction. When primary suture has been omitted, or has failed in consequence of suppuration, the separated ends of the tendon become adherent to adjacent structures, and the function of the associated muscle is impaired or lost. Under these conditions the operation of secondary suture is indicated. A free incision is necessary in order to discover and isolate the ends of the tendon; if the interval is too wide to admit of their being approximated by sutures, means must be taken to lengthen the tendon by suitably placed incisions.

*Avulsion of Tendons.*—This is a rare injury in which the tendons of a finger or toe are torn from their attachments along with the digit concerned. In the hand, it is usually brought about by the fingers being caught in the reins of a runaway horse, or being seized in a horse's teeth. It is usually the terminal phalanx that is separated, and with it the tendon of the deep flexor, which ruptures most frequently at its junction with the belly of the muscle in the forearm. The treatment consists in disinfecting the wound, closing the tendon sheath, and trimming the mutilated finger so as to provide a useful stump.

## Diseases of Muscle and Tendons.

*Congenital absence* of one or more muscles may be met with, usually in association with other congenital deformities. The pectoralis major, for example, may be absent on one or on both sides, without, however, causing any disability, as other muscles enlarge and take on its functions.

*Atrophy of Muscle.*—There is a form of atrophy or wasting of muscles described as *simple* because the muscle elements are merely diminished in size without undergoing any structural alteration. It is commonly met with as a result of disuse, as when a patient is confined to bed.

In cases of joint disease, the muscles of the affected region become atrophied more rapidly than is accounted for by disuse alone, and this is attributed to an interference with the trophic innervation of the muscles reflected from centres in the spinal cord. It is usually more marked in the extensor than in the flexor groups of muscles. Those affected become soft and

flaccid, exhibit tremors on attempted movement, and their excitability to the faradic current is diminished.

There is also a form, described as *neuropathic* atrophy because of its association with lesions of the nervous system. It is most pronounced in lesions of the motor nerve trunks, probably because vaso-motor and trophic fibres are involved as well as those which are purely motor in function. It is attended with definite structural alterations, the muscle elements first undergoing fatty degeneration, and then being absorbed, and replaced to a large extent by ordinary connective tissue and fat. At a certain stage the muscles exhibit the reaction of degeneration (p. 331). In the common form of infantile paralysis from disease in the anterior horns of the spinal cord, many fibres undergo fatty degeneration and are replaced by fat, while at the same time there is a regeneration of muscle fibres.

"**Muscular Rheumatism.**"—This clinical term is applied to a group of affections of which lumbago is the best-known example. The group includes lumbago, stiff-neck, and pleurodynia—conditions which have this in common, that sudden and severe pain is excited by movement of the affected part.

In *lumbago* the pain is usually located over the sacrum, the sacro-iliac joint, or the aponeuroses of the lumbar muscles on one or both sides. The amount of tenderness varies, and so long as the patient is quiet he is free from pain. The slightest attempt to alter the position of the back, however, is attended by pain, which may be so severe as to render him helpless for the moment. The pain is most marked on rising from the stooping or sitting posture and may shoot down the back of the hip, simulating sciatica. It is not uncommon for the patient to suffer from lumbago and sciatica at the same time. Once a patient has suffered from lumbago, it is very liable to recur, and an attack may be determined by errors of diet, changes of weather, or exposure to cold. It is met with chiefly in male adults, and is most apt to occur in those who are gouty or rheumatic, or the subjects of oxaluric dyspepsia.

In "*painful stiff-neck*" or rheumatic torticollis, the pain is located in one side of the neck, and is excited by some inadvertent movement. The head is held stiffly on one side as in wry-neck, the patient voluntarily contracting the sterno-mastoid. There may be tenderness over the vertebral spines or in the lines of the cervical nerves, and the sterno-mastoid may undergo atrophy. This affection is not uncommon in children.

In *pleurodynia* the pain is located to the side of the chest in

the line of the intercostal nerves, and is excited by movements of the chest, as in coughing, or by any bodily exertion. There is often marked tenderness.

A similar affection is met with in the *shoulder*, especially on waking from sleep. There is acute pain on attempting to abduct the arm, and there may be localised tenderness in the region of the circumflex nerve.

It would appear that these conditions, which have hitherto been regarded as specially affecting muscles, are in many cases dependent on a local nerve lesion such as neuritis or on some affection of the adjacent joints.

*Treatment.*—The general treatment is concerned with the diet, attention to the stomach, bowels, and kidneys, and with the correction of any gouty or rheumatic tendencies which may be present. The patient must persevere with movements and exercises, excepting those which specially excite the pain, and when heated must avoid exposure to cold. Great benefit may be derived from massage, and from the use of electricity, especially in cases in which the nerves are involved. In severe cases of lumbago, exercises are out of the question until the excessive pain and helplessness have been overcome by the application of heat, as by a hot-bottle or mustard poultice. Cupping or needling, or, in exceptional cases, hypodermic injections of antipyrin or morphin may be called for. To prevent relapses of lumbago, the patient must take systematic exercises of all kinds, especially those which bring out the movements of the spinal column and hips.

**Contracture of Muscles.**—Permanent shortening of muscles may result from the prolonged approximation of its points of attachment, or from structural changes in their substance produced either by injury or by disease. It is a frequent accompaniment, and sometimes a cause of certain deformities, in the treatment of which division of the contracted muscles may be an essential step.

An aggravated form of contracture sometimes follows upon the prolonged anæmia of muscles, such as is caused by tight bandaging or the use of the elastic tourniquet—*Volkmann's ischæmic paralysis.* In the upper extremity the muscles of the forearm undergo degeneration, and by contracting cause a claw-like deformity of the hand and fingers. The tendons of the contracted muscles may require to be lengthened.

**Myositis.**—Various forms of inflammation of *pyogenic* origin are met with in muscle, most frequently in relation to pyæmia and to typhoid fever. These may result in overgrowth of the

connective-tissue framework of the muscle and degeneration of its fibres, or in suppuration and the formation of one or more abscesses in the muscle substance. Repair may be associated with contracture. An evanescent form of myositis attended with considerable pain, may be met with as a result of infection with gonococci.

In the early secondary period of *syphilis*, the muscles may be the seat of dull, aching, nocturnal pains, especially in the neck and back. Reference must also be made to what is known as *syphilitic contracture*, a condition which has been observed chiefly in the later secondary period. The biceps of the arm, and the hamstrings in the thigh, are the muscles most commonly affected. The striking feature is a gradually increasing difficulty of extending the limb at the elbow or knee, and progressive flexion of the joint. The affected muscle is larger and firmer than normal, and its electric excitability is diminished. In tertiary syphilis, individual muscles may become the seat of interstitial myositis or of gummata, and these affections readily yield to anti-syphilitic remedies.

*Tuberculous disease* in muscle, while usually due to extension from adjacent tissues, is sometimes the result of a primary infection through the blood-stream. Tuberculous nodules are found disseminated throughout the muscle. The surrounding tissues are indurated, and central caseation may take place and lead to abscess formation and sinuses. We have observed this primary form of tuberculous disease in the gastrocnemius and in the psoas—in the latter muscle apart from tuberculous disease in the vertebræ.

**Tendinitis.**—German authors describe an inflammation of tendon as distinguished from inflammation of its sheath and give it the name tendinitis. It is met with most frequently in the tendo Achillis in gouty and rheumatic subjects who have overstrained the tendon, especially during cold and damp weather.

There is localised pain, aggravated by walking, and the tendon is sensitive and swollen from a little above its insertion to its junction with the muscle. Gouty nodules may form in its substance. In addition to constitutional measures, massage, and douching, the tendon should be protected from strain. The foot having been placed in the attitude of slight plantar flexion, a broad strip of plaster is applied from the middle of the calf, over the heel to the middle of the sole, and over this additional strips are applied at right angles to it.

**Ossification in Muscles, Tendons, and Fasciæ**—*Myositis Ossificans.*—Reference may be made in the first place to the

ossifications commonly met with in muscles, tendons, fasciæ, and ligaments, in those who are the subjects of arthritis deformans. They are seldom recognised clinically, but are frequently met with in the dissecting-room and in museums. Similar localised ossifications are met with in Charcot's disease of joints, and in fractures which have repaired with exuberant callus. The new bone may be in the form of spicules, plates, or irregular masses, which, when connected with a bone, are called *false* or *spurious exostoses.*

Another variety of ossification in muscle is that met with as a result of injury. Ossification in the crureus or vastus externus muscle has been observed chiefly after a severe blow on the thigh—such, for example, as a kick from a horse. Within a week or two a tumour appears at the site of injury, and becomes progressively harder until its consistence is that of bone. If the tumour moves with the affected muscle it causes but little inconvenience. If, as is commonly the case, it is fixed to the subjacent bone, the action of the muscle is impaired, and the patient complains of pain and difficulty in flexing the knee. A skiagram shows the extent of the mass and its relationship to the femur. The treatment consists in excising the bony mass. In some cases a hæmatoma with a fibrous wall and smooth lining membrane is found overlying the bony tumour.

A similar ossification has been observed in the brachialis anticus as a sequel of dislocation of the elbow. After successful reduction of the dislocation, the range of movement gradually diminishes and a hard swelling appears in front of the lower end of the humerus.

Ossification in the adductor longus was first described by Billroth under the name of "rider's bone." It is due to bruising and partial rupture of the muscle, and has been observed chiefly in cavalry soldiers. It causes no inconvenience except when riding, and is usually discovered accidentally.

Ossification in the deltoid and pectoral muscles has been observed in foot-soldiers in the German army, and has received the name of "drill-bone"; it is due to bruising of the muscle by the kicking of the butt of the rifle.

The formation of bone in muscle as a sequel to injury is usually regarded as the result of tearing or detachment of the periosteum. If a portion of periosteum is completely detached it may be drawn away into the muscle and there continue its bone-forming functions. That osteomata are capable of being formed in this way in the substance of muscle has been demonstrated by experiment.

Lastly, there is the interesting generalised disease—*progressive ossifying myositis*—in which the muscles, tendons, and fasciæ throughout the body become the seat of ossification. It affects almost exclusively the male sex, and is sometimes associated with congenital deformities of the fingers and toes. It usually begins in childhood or youth, sometimes after an injury, sometimes without any apparent cause. The muscles of the back, especially the trapezius and latissimus, are the first to be affected, and the initial complaint may be of limitation of movement. On examination the bony nodules are seen and felt, and they may be shown in skiagrams. In the first instance they have no connection with the periosteum. As time goes on these bony nodules increase in number and size, and tend to fuse into larger masses. The spine becomes rigid, the head is bent forward, the hips are flexed, and abduction and other movements of the arms limited. The disease progresses by fits and starts until all the striped muscles of the body may be ossified, and all movements, even those of the jaws, may be abolished. It is generally fatal within ten or twelve years from its onset, death usually resulting from pulmonary complications. There is no means of arresting the disease, and surgical treatment is restricted to the removal of any mass of bone which interferes with an important movement.

The osseous tissue found in muscle is derived from its connective tissue framework, the muscle fibres themselves undergoing atrophy and absorption. The bone is spongy in character, and its development takes place along similar lines to those normally observed in the periosteum.

**Tumours of Muscle.**—With the exception of certain rare congenital varieties, such as the rhabdomyoma, tumours of muscle grow from the connective-tissue framework and not from the muscle fibres. Innocent tumours, such as the fibroma, lipoma, angioma, and neuro-fibroma, are very rare. Malignant tumours may be primary in the muscle, or may result from extension from adjacent growths—for example, implication of the pectoral muscle in cancer of the breast—or may be derived by metastasis from tumours situated elsewhere. The diagnosis of an intramuscular tumour is made by observing that the swelling is situated beneath the deep fascia, and that it becomes firm and fixed when the muscle is contracted. When the muscle is relaxed, the tumour becomes softer, and can be moved in the transverse axis of the muscle, but not in its long axis. The same remarks apply to a gumma or mass of bone within the muscle.

Clinical interest chiefly attaches to that form of slowly growing fibro-sarcoma—*the recurrent fibroid of Paget*—which

is most frequently met with in the muscles of the abdominal wall. A rarer variety is the chondro-sarcoma, which may undergo ossification to such an extent as to be visible in skiagrams.

In primary sarcoma the treatment consists in removing the muscle. In the limbs, the function of the muscle that is removed may be retained by transplanting an adjacent muscle in its place. We have carried this out in an ossifying sarcoma of the muscles of the calf by stitching the divided peroneus longus into the tendo Achillis.

Hydatid cysts of muscle are very rare.

## DISEASES OF TENDON SHEATHS.

Tendon sheaths have the same structure and function as the synovial membranes of joints, and are liable to the same diseases.

**Teno-synovitis.**—The toxic or infective agent which causes inflammation of tendon sheaths is either conveyed to them through the blood-stream, as in the gouty, gonorrhœal, and tubercuIous varieties, or is introduced directly through a wound, as in the common septic form of teno-synovitis.

*Simple Teno-synovitis.*—In the simple or traumatic form of teno-synovitis, although the most prominent etiological factor is a strain or over-use of the affected tendon, there would appear to be some other, probably a toxic, factor in its production, otherwise the affection would be much more common than it is: only a very small proportion of those who strain or over-use their tendons become the subjects of teno-synovitis. The opposed surfaces of the tendon and its sheath are covered with an exudation of fibrinous lymph, so that there is friction when these move on one another.

The *clinical features* are pain on movement, tenderness on pressure over the affected tendon, and a sensation of crepitation or friction when the tendon is moved in its sheath. The crepitation may be soft like the friction of snow, or may resemble the creaking of new leather—"saddle-back creaking." There may be swelling in the long axis of the tendon, and redness and œdema of the skin. If there is an effusion of fluid into the sheath, the swelling is more marked and crepitation is absent. There is usually little tendency to the formation of adhesions.

*Treatment.*—When the extensor tendons of the thumb or fingers are affected, the pain is relieved by lead and opium fomentations, or by glycerin and belladonna, and the forearm and hand should be immobilised on a palmar splint. The later treatment consists in massage and movement of the thumb and fingers. Any constitutional or gastro-intestinal derangement should be corrected by appropriate diet and medicinal treatment.

The condition is common in the tendons about the wrist, particularly in the extensors of the thumb, and it is most frequently met with in those who follow occupations which involve prolonged use, or excessive straining of these tendons, for example, in washerwomen or in riveters. It also occurs as a result of excessive piano-playing, fencing, or rowing.

At the ankle it may affect the peronei, the extensor longus digitorum, or the tibialis anticus. It is most often met with in relation to the tendo Achillis—*Achillo-dynia*—and results from the pressure of ill-fitting boots or from the excessive use and strain of the tendon in cycling, walking, or dancing. There is pain and difficulty in raising the heel from the ground, and creaking can be felt on palpation. It readily subsides under rest and the application of a blister, but it is apt to relapse on a repetition of the exciting cause.

In the upper arm the sheath of the long tendon of the biceps may be affected.

*Gouty Teno-synovitis.*—A deposit of urate of soda beneath the endothelial covering of tendons or of that lining their sheaths is commonly met with in gouty subjects. The accumulation of urates may result in the formation of visible nodular swellings, varying in size from a pea to a cherry, which are attached to the tendon and move with it. They may be merely unsightly, or they may interfere with the use of the tendons. Recurrent attacks of inflammation sometimes occur. We have removed gouty masses on account of one or other of these indications, with satisfactory results.

*Suppurative Teno-synovitis.*—This form usually follows upon infected wounds of the fingers—especially of the thumb or little finger—and is a frequent sequel to whitlow. It may also follow the amputation of a finger. Once the infection has gained access to the sheath, it tends to spread, and may reach the palm or even the forearm, being then associated with cellulitis. There is considerable fever, pain, and swelling. In moderately acute cases the tendon and its sheath become covered with granulations, which subsequently lead to the

formation of firm adhesions; while in more acute cases the tendon may slough. The pus may burst into the cellular tissue outside the sheath, and the suppuration may spread to neighbouring sheaths or to adjacent bones or joints—for example, those of the wrist.

The *treatment* consists in employing Bier's congestion, or incision and drainage. As soon as the inflammation has subsided, active and passive movements are employed in order to prevent the formation of adhesions between the tendon and its sheath. If the tendon sloughs, the dead portion should be cut away, as its separation is extremely slow.

*Gonorrhœal Teno-synovitis.*—This is met with especially in the tendon sheaths about the wrist and ankle. It may occur in a mild form, with pain, impairment of movement, and œdema, and sometimes an elongated, fluctuating swelling develops, the result of serous effusion into the sheath. This condition may alternate with a gonorrhœal affection of one of the large joints. It usually subsides under rest and soothing applications, but is liable to relapse. In the more severe variety the skin is red, and the swelling partakes of the characters of a phlegmon with threatening suppuration. Even if the sheath is filled with pus, the tendon rarely sloughs. This form should be incised.

*Tuberculous Disease of Tendon Sheaths.*—This is a comparatively common affection, and is analogous to tuberculous disease of the synovial membrane of joints. It may originate in the sheath, or may spread to it from disease in an adjacent bone.

The commonest form—hydrops—is that in which the synovial sheath is distended with a viscous fluid, and the fibrinous material on the free surface becomes detached and is moulded into melon-seed bodies by the movement of the tendon. The sheath itself is thickened by the growth of tuberculous granulation tissue, which subsequently undergoes degeneration. The bodies vary greatly in size and shape, are of a dull-white colour, and have smooth surfaces (Fig. 254). There may be an overgrowth of the fatty fringes of the synovial sheath, a condition described as "arborescent lipoma."

The *clinical features* vary with the tendon sheath affected. In the common flexor sheath of the hand an hour-glass-shaped swelling is formed, bulging above and below the annular ligament—formerly known as *compound palmar ganglion* (Fig. 88). There is little or no pain, but the fingers tend to be stiff and weak, and they may become flexed. On palpation, it is usually possible to displace the contents of the sheath from one compartment to the other, and this may yield fluctuation, and,

what is more characteristic, a peculiar crunching sensation from the movement of the melon-seed bodies against one another. In the sheath of the peronei or other tendons about the ankle the swelling is sausage-shaped, and is constricted opposite the annular ligament.

The onset and progress of the affection are most insidious, and the condition may remain stationary for long periods. It is aggravated by use or strain of the tendons involved. In exceptional cases the skin is thinned and gives way, leading to the formation of a discharging sinus. The prognosis is influenced by the general condition of the patient and the existence of tuberculous lesions elsewhere.

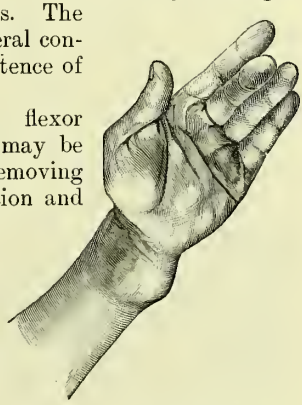


FIG. 88.—Tuberculous Disease of Sheaths of Flexor Tendons.

(Mr. J. M. Cotterill's case.)

*Treatment.* — In the common flexor sheaths of the palm, an attempt may be made to cure the condition by removing the contents through a small incision and filling the cavity with iodoform emulsion. The distended sheath is laid open, the contents removed, the wall scraped and swabbed out with pure carbolic acid, and the wound closed. During the after treatment it is important to maintain movement of the fingers.

A less common form of tuberculous disease is that in which the sheath becomes the seat of *a diffuse tuberculous thickening*, not unlike the white swelling met with in joints, and with a similar tendency to caseation. There is an absence of fluid and of melon-seed bodies. A painless swelling of an elastic character forms in relation to the tendon sheath. It is hour-glass-shaped in the common flexor sheath of the palm, elongated or sausage-shaped in the extensors of the wrist and in the tendons at the ankle. Although resembling the previous form in being slow in progress and of long duration, it is more liable to result in invasion of the tendons and interference with their functions. It is also more liable to break down and lead to the formation of abscesses and sinuses, and in our experience is more often associated with disease in an adjacent bone or joint. In the peronei tendons, for example, it may result from disease of the fibula or of the ankle-joint.

As a rule the diagnosis is easy, but the local appearances closely resemble those of innocent tumours of tendon sheaths.

*Treatment.*—Excision of the affected sheath is the only satisfactory treatment. The whole of the diseased area must be exposed by free incision of the overlying soft parts; the sheath is then carefully isolated from the surrounding tissues and cut across above and below. Any tuberculous tissue on the tendon itself is removed with a sharp spoon. Associated bone or joint lesions are dealt with at the same time. In the after-treatment the functions of the tendons must be preserved by voluntary and passive movements.

*Syphilitic Affections of Tendon Sheaths.*—These closely resemble the syphilitic affections of the synovial membrane of joints. During the secondary period the lesion usually consists in effusion into the sheath; gummata are met with during the tertiary period.

*Tumours of Tendon Sheaths.*—Innocent tumours are very rare. Their clinical features resemble tuberculous disease so closely that the diagnosis is often extremely difficult. The *lipoma*, *fibroma*, and *myxoma* resemble similar tumours in other situations. Special mention should be made of the *myeloma* which is met with at the wrist or ankle as an elongated swelling of slow development, or over the phalanx of a finger as a small rounded swelling. The tumour tissue, when exposed by dissection, is of a chocolate or chamois-yellow colour, and consists almost entirely of giant cells. The treatment consists in dissecting the tumour tissue off the tendons, and this is usually successful in bringing about a permanent cure.

All varieties of *sarcoma* are met with, but their origin from tendon sheaths is not associated with any special features. In removing them it may be necessary to sacrifice the tendons or to amputate the limb.

# CHAPTER XIX.

## THE BURSÆ.

Anatomy—Normal and adventitious bursae—Injuries: Bursal hæmatoma —Diseases: Traumatic or trade bursitis; Bursal hydrops; Solid bursal tumour; Gonorrhœal and suppurative forms of bursitis; Tuberculous and syphilitic disease—Tumours—*Diseases of individual bursæ in the upper and lower extremities.*

A BURSA is a closed sac lined by endothelium and containing synovia. Some are normally present—for example, that between the skin and the patella, and that between the aponeurosis of the gluteus maximus and the great trochanter. *Adventitious bursæ* are developed as a result of abnormal pressure, for example, over the tarsal bones in certain cases of club-foot.

**Injuries of Bursæ.**—As a result of contusion, hæmorrhage may occur into the cavity of a bursa and give rise to a bursal hæmatoma. This is especially liable to occur in bleeders. Such a hæmatoma may mask a fracture of the bone beneath—for example, fracture of the olecranon process. Acute suppuration is a frequent sequel of infected wounds.

**Diseases of Bursæ.**—The lining membrane of bursæ resembles that of joints and tendon sheaths, and is liable to the same forms of disease.

**Trade or Traumatic Bursitis.**—This term may be conveniently applied to certain affections of bursæ which appear to result from repeated slight traumatism incident to particular occupations. The most familiar examples of these are the enlargement of the prepatellar bursa met with in housemaids —the housemaid's knee (Fig. 91); the enlargement of the olecranon bursa—miner's elbow; or ischial bursa—weaver's or tailor's bottom (Fig. 89). These affections are characterised by an effusion of fluid into the sac of the bursa with more or less thickening of its lining membrane. While friction and pressure

constitute the most evident factors in their production, it is probable that there is also some toxic agent concerned, otherwise these affections would be much more common than they are. Of the countless housemaids in whom the prepatellar bursa is subjected to friction and pressure, only a small proportion become the subjects of housemaid's knee.

*Clinical features.*—As these are best illustrated in the different varieties of prepatellar bursitis, it is convenient to take this as the type. In acute cases, the part is hot, swollen, and tender, and fluctuation may be detected in the bursa. The patient may be obliged to lie up. In the majority of cases the chief feature is the gradual accumulation of fluid constituting the *bursal hydrops* or *hygroma.* When the affection has lasted some time, or has frequently relapsed, the wall of the bursa becomes thickened by fibrous tissue. The fibrous thickening may be quite irregular and result in the formation of septa, bands or fringes not unlike those met with in arthritis deformans. The detachment of fringes may give rise to loose bodies like those met with in joints. Less frequently there are fibrinous bodies of the melon-seed type, sometimes moulded into circular discs like wafers. The presence of irregular thickenings of the wall, or of loose bodies, may be recognised on palpation—especially in superficial bursæ, if the sac is not tensely distended with fluid. Thickening may take place in a uniform and concentric fashion, resulting in the formation of a fibrous tumour—*the solid bursal tumour*—a small cavity containing a little fluid remaining in the centre.

The *treatment* varies according to the variety and stage of the affection. In recent cases the symptoms subside under rest and the application of fomentations. Hydrops may be got rid of by blistering, by tapping, or by incision and drainage. When the wall is thickened the most satisfactory treatment is to excise the bursa. The overlying skin should be reflected downwards in the shape of a horse-shoe flap.

**Other Diseases of Bursæ** are associated with *gonorrhœal infection*, and with *rheumatism*, especially that following scarlet fever, and are apt to be very persistent or to relapse after apparent cure. In the *gouty* form urate of soda is deposited in the wall of the bursa, and may result in the formation of chalky tumours, sometimes of considerable size.

The *suppurative form* may be due to the extension of infection from adjacent tissues—for example, from suppuration in a joint or in the cellular tissue; but it usually results from an infected wound implicating the bursa, or the skin and sub-

cutaneous tissue over it. It is frequently met with in the olecranon bursa after a fall on the elbow, or in the prepatellar bursa from a similar injury. There is redness of the skin, great swelling and œdema of the part, and, if untreated, the septic process may transgress the wall of the bursa, invade the surrounding cellular tissue, and spread up and down the limb. The condition may simulate erysipelas.

*Tuberculous disease* of bursæ closely resembles that of tendon sheaths. It may occur as an independent affection, or may be associated with tuberculous disease in an adjacent bone or joint. It is met with chiefly in the prepatellar and subdeltoid bursæ, or in one of the bursæ over the great trochanter. The clinical features are those of an indolent hydrops, with or without melon-seed bodies, or of uniform thickening of the wall of the bursa, which sometimes breaks down into a cold abscess and gives rise to persistent sinuses. The best treatment is to excise the affected bursa, or, where this is impracticable, to lay it freely open, remove the tuberculous tissue with the sharp spoon, and treat the resulting cavity by the open method.

*Syphilitic disease* is rarely recognised except in the form of bursal and peri-bursal gummata in front of the knee-joint.

*Tumours* of bursæ include the fibroma, the myxoma, the myeloma or giant-celled tumour, and various forms of sarcoma. They present the same clinical features, and are treated on the same lines, as similar tumours elsewhere.

**Diseases of Individual Bursæ.**—In the upper extremity, the *olecranon* bursa is frequently the seat of traumatic or trade bursitis and the affection is known as "miner's" or "student's elbow." The *subdeltoid* bursa may be distended with fluid as a result of trauma or tuberculous disease, and form a painful swelling on the outer aspect of the shoulder (Codman). The bursa underneath the tendon of the *subscapularis* muscle when inflamed causes alteration in the attitude of the shoulder and impairment of its movements. An adventitious bursa forms over the *acromion* process in porters and others who carry weights on the shoulder and may be the seat of traumatic bursitis. The bursa under the *radial tendon of the biceps*, when the seat of disease, is attended with pain and swelling at the insertion of the biceps tendon about a finger-breadth below the bend of the elbow; there is pain and difficulty in effecting the combined movement of flexion and supination, slight limitation of extension, and restriction of pronation.

In the lower extremity a large number of normal and adventitious bursæ are met with. That over the *tuberosity of*

*the ischium* when enlarged as a trade disease is known as



FIG. 89.—Great Enlargement of the Ischial Bursa.
(Mr. Scot Skirving's case.)

"weaver's" or "tailor's bottom." It may form a fluctuating swelling of great size, projecting on the buttock and extending down the thigh, and causing great inconvenience in sitting (Fig. 89). There are two bursæ over the *great trochanter*, one superficial to, the other beneath the aponeurosis of the gluteus maximus; the latter is not infrequently infected by tuberculous disease spreading from the trochanter.

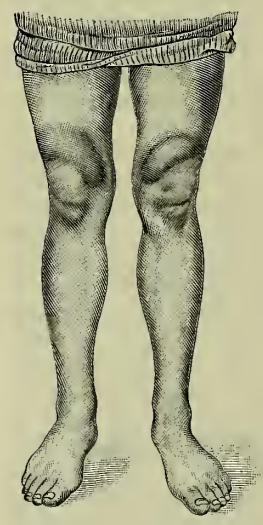


FIG. 90.—Bilateral Hydrops of Subcrural Bursa.
(Mr. F. M. Caird's case.)

The bursa between the *psoas* and the capsule of the hip-joint may be the seat of tuberculous disease and give rise to clinical features not unlike those of disease of the joint. The limb is flexed, abducted and rotated out, there is a distinct swelling in the upper part of Scarpa's triangle, but the movements are not restricted in directions which do not entail putting the ilio-psoas muscle on the stretch.

The bursa beneath the quadriceps extensor — *subcrural bursa* — usually communicates freely with the knee-joint and shares in its diseases. When shut off from the knee it may

suffer independently, and when distended with fluid forms a horse-shoe swelling above the patella (Fig. 90).

In front of the *patella and its ligament* there is a bursa



FIG. 91.—Hydrops of Prepatellar Bursa in a housemaid.

which may have one, two, or three compartments, usually communicating with one another. It is the seat of the affection known as housemaid's knee (Fig. 91)—which has already been described (p. 396). The bursa *between the ligamentum patellæ and the tibia* is very rarely the seat of independent disease. When it is, there is pain and tenderness referred to the ligament, the patient is unable to extend the limb completely, the tubercle of the tibia is apparently enlarged, and there is a fluctuating swelling on either side of the ligament, most marked in the extended position of the limb.



FIG. 92.—Enlarged Semi-Membranosus Bursa.

Of the numerous bursæ in the popliteal space, that between the *semimembranosus* and the inner head of the gastrocnemius is most frequently the seat of disease, which is usually of the nature of a simple hydrops, forming a fluctuating egg- or sausage-shaped swelling at the inner side of the popliteal space (Fig. 92). It is flaccid in the flexed, and tense in the extended position of the limb. As a rule it causes little inconvenience and may be left alone. Otherwise it should be dissected out, and if, as is frequently the case, there is a communication with the knee-joint, this should be closed with sutures. An adventitious bursa may form over the

*external malleolus*, especially in tailors, giving rise to the condition known as "tailor's ankle" (Fig. 93). The bursa between *the tendo Achillis and the upper part of the os calcis* may become inflamed —especially as a result of post-scarlatinal rheumatism or gonorrhœa. The affection is known as Achillo-bursitis. There is severe pain in the region of the insertion of the tendo Achillis, and the movements at the ankle-joint are restricted and the patient may be unable to walk. There is a tender swelling on either side of the tendon. When, in spite of palliative treatment, the affection persists or relapses, it is best to excise the bursa. The tendo Achillis is detached from the os calcis, the bursa dissected out, and the tendon replaced. If there is a bony projection from the os calcis, as sometimes occurs, it should be shaved off with the chisel.



FIG. 93.—Gouty Disease of Bursæ in a tailor. The bursal tumours were almost entirely composed of urate of soda.

The bursa which is sometimes met with on the under aspect of the os calcis—*the subcalcanean bursa*—when inflamed, gives rise to marked local pain and tenderness in the sole of the foot. This affection may be associated with a spinous projection from the bone, which is capable of being recognised in a skiagram. The soft parts of the heel are turned forwards as a flap, the bursa is dissected out, and the projection of bone, if present, is removed.

The enlargement of adventitious bursæ over the head of the first metatarsal in hallux valgus; over the tarsus, metatarsus, and digits in the different forms of club-foot; over the angular projection in Pott's disease of the spine; over the end of the bone in amputation stumps, and over hard tumours such as chondroma and osteoma, are described elsewhere.

# CHAPTER XX.

## INJURIES OF BONES.

Contusions—Wounds—Fractures: *Pathological; Traumatic; Varieties*—Simple fractures—Compound fractures—Separation of Epiphyses—Repair of fractures—Interference with repair.

The injuries to which a bone is liable are Contusions, Open Wounds, and Fractures.

**Contusions of Bone** are almost of necessity associated clinically with similar injuries of the overlying soft parts. The mildest degree consists in a bruising of the periosteum, which is raised from the bone by an effusion of blood, constituting a *hæmatoma of the periosteum*. This may be rapidly and completely absorbed, or it may give place to a thickening of the bone (*traumatic node*), which may persist for long and be attended with deep-seated pain. A contusion may play a part in the etiology of acute osteo-myelitis and of tuberculosis, by furnishing an area of depressed tissue for the lodgment of bacteria circulating in the blood.

*Treatment.*—Rest, elevation, the application of lead and opium fomentations, or of an ice-bag, constitute the best methods of treatment during the first few days. Later, massage and the internal administration of potassium iodide favour the absorption of effusions and nodes.

When the skin is broken the condition approaches that of a compound fracture, and is treated on the same lines.

**Open Wounds of Bone** of the incised and contused varieties are usually produced by cuts with sabres, axes, butcher's knives, scythes, or by circular saws. Punctured wounds are caused by bayonets, arrows, or other pointed instruments. They are all equivalent to compound, incomplete fractures.

*Gun-shot injuries* of bone have already been described (p. 228).

## FRACTURES

A fracture may be defined as a sudden and violent solution in the continuity of a bone.

### Pathological or Spontaneous Fractures.

A pathological or spontaneous fracture has as its primary cause some definite pathological state of the bone, which permits of its giving way on the application of a force which would be quite insufficient to break a healthy bone, and which merely hastens its complete severance. The following conditions may be mentioned as predisposing to pathological fracture.

*Atrophy* of bone may proceed to such an extent in old people, or in those who for long periods have been bed-ridden, that the slightest violence suffices to determine a fracture. This most frequently occurs in the neck of the femur in old women, the mere exertion of turning in bed being sometimes sufficient to cause the break. Atrophy from the pressure of an aneurysm or of a simple tumour may erode the whole thickness of a bone, or may thin it out to such an extent that very slight force is sufficient to break it. In general paralytics, and in patients in the advanced stages of locomotor ataxia and other chronic diseases of the nervous system, an eccentric atrophy of all the bones sometimes takes place, and may proceed so far that multiple fractures are induced by trifling causes. They occur painlessly, most frequently in the ribs or long bones of the limbs, and usually unite satisfactorily, although with an excessive amount of callus. Attendants and nurses must be warned against using force in handling such patients, as otherwise they may be unfairly blamed for causing these fractures.

*Fragilitas ossium* is the name applied to a condition, often hereditary, and frequently met with in infants, in which all the bones of the body are excessively fragile, and favour the occurrence of multiple fractures, which usually heal with considerable deformity. *Rickets* and *scurvy* may be attended with a similar fragility of the bones.

*Osteo-myelitis, tuberculous and syphilitic disease*, and certain *tumours*, especially sarcomata growing in the interior of bones, predispose to fracture. Indeed, it is not unusual for the sudden breaking of the bone to be the first intimation of the existence of the tumour.

*Intra-uterine fractures* and fractures occurring *during birth*

are usually associated with some form of external violence, but it is believed that in the majority of cases the fœtus is the subject of some constitutional disease which weakens the bones, such as rickets or syphilis.

### Traumatic Fractures.

Traumatic fractures are usually the result of a severe force acting from without, although sometimes they are produced by powerful muscular contraction.

When the bone gives way at the point of impact of the force, the violence is said to be *direct*, and a "fracture by compression" results, the line of fracture being as a rule transverse. The soft parts overlying the fracture are more or less damaged according to the weight and shape of the impinging body. Fracture of both bones of the leg from the passage of a wheel over the limb, fracture of the shaft of the ulna in warding off a stroke aimed at the head, and fracture of a rib from a kick, are illustrative examples of common fractures by direct violence.

When the force is transmitted to the seat of fracture from a distance, the violence is said to be *indirect*, and the bone is broken by "torsion" or by "bending." In such cases the bone gives way at its weakest point, and the line of fracture tends to be oblique. Thus both bones of the leg are frequently broken by a person jumping from a height and landing on the feet, the tibia breaking in its lower third, and the fibula at a higher level. Fracture of the clavicle in its middle third, or of the radius at its lower end, from a fall on the outstretched hand, are common accidents produced by indirect violence. The ribs also may be broken by indirect violence, as when the chest is crushed antero-posteriorly, the bones bending beyond the limits of their elasticity, and giving way near their angles. In such fractures the soft parts do not suffer by the violence causing the fracture, but they may be injured by displacement of the fragments.

In fractures by *muscular action* the bone is broken by "traction" or "tearing." The sudden and violent contraction of a muscle may tear off an epiphysis, such as the head of the fibula, the anterior-superior iliac spine, or the coronoid process of the ulna; or a bony process may be separated, as, for example, the tuberosity of the os calcis, the coracoid process of the scapula, or the greater tuberosity of the humerus. Long bones also may be broken by muscular action. The clavicle

has snapped across during the act of swinging a stick, the humerus in throwing a stone, and the femur when a kick has missed its object. Fractures of ribs have occurred during fits of coughing or in the violent efforts of parturition.

Before concluding that a given fracture is the result of muscular action alone, it is necessary to exclude the co-existence of any of the conditions which lead to pathological fracture.

Although the force acting upon the bone is the primary factor in the production of fractures, there are certain subsidiary factors to be considered. Thus the age of the patient is of importance. During infancy and early childhood fractures are less common than at any other period of life, and are usually transverse, incomplete, and of the nature of bends. During adult life, especially between the ages of thirty and forty, the frequency of fractures reaches its maximum. In aged persons, although the bones become more brittle, by the marrow spaces in their interior becoming larger and filled with fat, fractures are less frequent, doubtless because the old are less exposed to such violence as is likely to produce fracture.

Males, from the nature of their occupations and recreations, sustain fractures much more frequently than do females, except in old age, when the opposite is the case.

A liability to fracture is often hereditary, members of certain families showing a marked predisposition to this form of injury.

Bennett of Dublin has drawn attention to the fact that the characters of a given fracture may be inferred from a consideration of—(1) the shape and structure of the affected bone, and (2) the nature of the fracturing force. As there is great uniformity in the shape, construction, and relative strength of a particular bone in different subjects, and as each part of any particular bone is liable to the same kinds and degrees of external violence or muscular strain, it follows that individual fractures conform more or less closely to a particular type. Thus, for example, the "typical fracture" of the clavicle resulting from indirect violence occurs in the middle third of the bone and is oblique (Fig. 105); while direct violence generally produces a transverse fracture near the outer end of the bone. The typical fracture of the bones of the leg caused by direct force is transverse, and occurs in the lower third; while indirect violence produces an oblique fracture of the tibia low down, and of the fibula higher up (Figs. 202, 203).

**Clinical Varieties of Fractures.**—The most important subdivision of fractures is that into simple and compound.

In a *simple* or subcutaneous fracture there is no communication, directly or indirectly, between the broken ends of the bone and the surface of the skin. In a *compound* or open fracture, on the other hand, such a communication exists, and, by furnishing a means of entrance for bacteria, may add materially to the gravity of the injury.

A simple fracture may be complicated by the existence of a wound of the soft parts, which, however, does not communicate with the broken bone.

Fractures, whether simple or compound, fall into other clinical groups, according to (1) the degree of damage done to the bone, (2) the direction of the break, and (3) the relative position of the fragments.

(1) *According to the Degree of Damage done to the Bone.*— A fracture may be incomplete — for example, in *greenstick fractures* which occur only in young persons—usually below the age of twelve—while the bones are still soft and flexible. They result from forcible bending of the bone, the osseous tissue on the convexity of the curve giving way, while that on the concavity is compressed. The clavicle, radius, and ulna are the bones which most frequently suffer in this way (Fig. 143). *Fissures* may occur on the flat bones of the skull, the pelvic bones, or the scapula; or in association with other fractures in long bones (Fig. 96), when they often run into joint surfaces. Clinically they can only be recognised when compound. *Depressions* or indentations are most common in the bones of the skull, but sometimes occur in other bones.

The bone at the seat of fracture may be broken into several pieces, constituting a *comminuted* fracture. This usually results from severe degrees of direct violence, such as are sustained in railway or machinery accidents, and from gun-shot wounds.

*Sub-periosteal* fractures are those in which, although the bone is completely broken across, the periosteum remains intact. These are especially common in children, and as the thick periosteum prevents displacement, the existence of a fracture may be overlooked, even in such a bone as the femur.

A bone may be broken at several places, constituting a *multiple* fracture (Fig. 94).

*Separation of bony processes*, such as the coracoid process, the epicondyle of the humerus, or the tuberosity of the os calcis, may result from muscular action or from direct violence. *Separation of epiphyses* will be considered later.

(2) *According to the Direction of the Break.*—*Transverse* fractures are those in which the bone gives way more or less

exactly at right angles to its long axis. These usually result from direct violence or from end to end pressure. *Longitudinal* fractures extending the greater part of the length of a long bone are exceedingly rare. *Oblique* fractures are very common, and result usually from indirect violence, bending, or torsion (Figs. 96, 97). *Spiral* fractures result from forcible torsion of a long bone, and are met with most frequently in the tibia, femur, and humerus (Fig. 95).



FIG. 94.—Multiple Fracture of Tibia and Oblique Fracture of Fibula, the result of a cable-car accident.

(3) *According to the Relative Position of the Fragments.*—The bone may be completely broken across, yet its ends remain in apposition, in which case there is said to be *no displacement*. There may be an *angular* displacement—for example, in greenstick fracture; or the ends may *overlap* one another although they do not completely part company. In transverse fractures of the patella or of the olecranon there is often *distraction* or pulling apart of the fragments (Fig. 197). The broken ends, especially in oblique fractures, may *override* one another, and so give rise to shortening of the limb. Where one fragment is acted upon by powerful muscles a *rotatory* displacement may take place, as in fracture of the radius above the insertion of the pronator radii teres, or of the femur just below the small trochanter. The fragments may be *depressed*, as in the flat bones of the skull or the nasal bones. At the cancellated ends of long bones, particularly the upper end

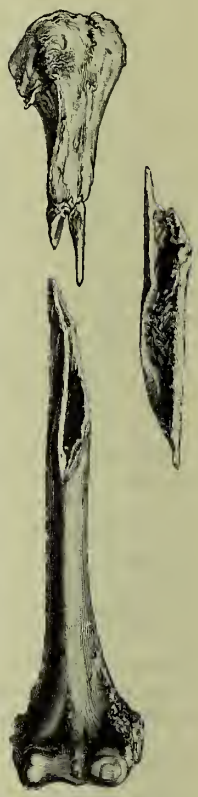


FIG. 95.—Spiral Fracture of Humerus, caused by torsion of the upper arm in an old woman.

of the femur and humerus, and the lower end of the radius, it is not uncommon for one fragment to be *impacted* or wedged into the substance of the other (Fig. 176).



Fig. 96. — Oblique Fracture of Upper Third of Tibia with Fissuring of Lower Fragment. Limb run over by a railway waggon.

*Causes of Displacement.* —The factors which influence displacement are chiefly mechanical in their action. Thus the direction and nature of the fracture play an important part. Transverse fractures with roughly serrated ends are less liable to displacement than those which are oblique with more or less smooth surfaces. The direction of the causal force also is a dominant factor in determining the direction in which one or both of the fragments will be displaced. Gravity, acting chiefly upon the distal fragment, also plays a part in determining the displacement, for example, in fractures of the thigh or of the bones of the leg, where the lower segment of the limb rolls outwards (Fig. 171), and in fractures of the shaft of the clavicle where the weight of the arm carries the shoulder downwards, forwards, and inwards. After the break has taken place and the causal force has ceased to act, displacement may be produced by rough handling on the part of those who render first aid, the careless or improper application of splints or bandages, or by the weight of the bedclothes.



Fig. 97. — Showing (1) Oblique Fracture of Tibia; (2) Oblique Fracture with partial Separation of Epiphysis of Upper End of Fibula; (3) Incomplete Fracture of Fibula in Upper Third. Result of railway accident. Boy æt. 16.

In certain situations the contraction of unopposed, or of unequally opposed, groups of muscles plays an important part in

determining the displacement. For example, in fracture immediately below the lesser trochanter of the femur (Fig. 178), the ilio-psoas tends to tilt the upper fragment forward and outward; in supra-condylar fracture of the femur, the muscles of the calf pull the lower fragment back towards the popliteal space; and in fracture of the humerus above the deltoid insertion, the muscles inserted into the bicipital groove adduct the upper fragment.

**Clinical Features of Simple Fractures.**—In the first place, the *history of the accident* should be investigated, attention being paid to the nature of the violence—whether a blow, a twist, a wrench, or a crush, and whether the violence was directly or indirectly applied. The degree of the violence may often be judged approximately from the instrument inflicting it—whether, for example, a fist, a stick, a cart wheel, or a piece of heavy machinery. The position of the limb at the time of the injury; whether the muscles were braced to meet the blow or were lax and taken unawares; and the patient's sensations at the moment, such as his feeling something snap or tear, may all furnish information useful for purposes of diagnosis.

*Signs of Fracture.*—The most characteristic signs of fracture are unnatural mobility, deformity, and crepitus.

*Unnatural mobility*—that is, movement between two segments of a limb at a place where movement does not normally occur—may be evident when the patient makes attempts to use his limb, or may only be elicited when the fragments are seized and moved in opposite directions or rotated. *Deformity*, or the part being "out of drawing" in comparison with the normal side (Figs. 143 and 204), varies with the site and direction of the break, and depends upon the degree of displacement between the fragments. *Crepitus* is the name applied to the peculiar grating or clicking which may be heard or felt when the fractured surfaces are rubbed against one another.

The presence of these three signs in association is sufficient to prove the existence of a fracture, but the absence of one or more of them does not negative this diagnosis. There are certain fallacies to be guarded against. For example, a fracture may exist and yet unnatural mobility may not be present, because the bones are impacted into one another, or because the fracture is an incomplete one. Again, the extreme tension of the swollen soft tissues overlying the fracture may prevent the recognition of movement between the fragments. Deformity also may be absent—as, for instance, when there is no

displacement of the fragments, or where only one of two parallel bones is broken, as in the leg or forearm. Similarly, crepitus may be absent when impaction exists, when the fragments completely override one another, or are separated by an interval, or when soft tissues, such as torn periosteum or muscle, are interposed between them. A sensation closely resembling crepitus may be felt over a large extravasation of blood, over effusions into tendon sheaths, and over joints in certain chronic diseases. The rubbing of the dislocated end of a bone against the fibrous tissues amongst which it lies, and the crackling of air in subcutaneous emphysema, also closely simulate the crepitus of fracture.

It is not advisable to be very diligent in eliciting these signs at the bedside, partly because of the pain caused by the manipulations, and partly because vigorous handling may do harm by undoing impaction, or by producing displacement which does not already exist, or by converting a simple into a compound fracture.

It is often necessary for purposes of diagnosis to administer a general anæsthetic, particularly in injuries of deeply placed bones and in the vicinity of joints. Before doing so, the appliances necessary for the treatment of the injury should be made ready, in order that the fracture may be reduced and set before the patient regains consciousness.

*Radiography in the Diagnosis of Fractures.*—While radiography is of inestimable value in the diagnosis of many fractures and other injuries, particularly in the vicinity of joints, the student is warned against relying too implicitly on the evidence it seems to afford.

A radiogram is not a photograph of the object exposed to the X-rays, but merely a picture of its shadow. As the rays emanate from a single point in the vacuum tube, and as they are not, like the sun's rays, approximately parallel, the shadows they cast are necessarily distorted. Hence, in interpreting a radiogram, it is necessary to know the relative positions of the point from which the rays proceed, the object exposed, and the photographic plate on which the shadow is registered. The least distortion takes place when the object is in contact with the plate, and the shadow of that part of the object which lies perpendicularly under the light is less distorted than that of the parts lying outside the perpendicular. The light and the plate remaining constant, the amount of distortion varies directly with the distance between the object and the plate.

To ensure accuracy in the diagnosis of fracture by the X-rays,

it is necessary to take two views of the limb—one in the sagittal and the other in the coronal plane. By the use of the fluorescent screen, the best positions from which to obtain a clear impression of the fracture may be determined before the radiograms are taken.

Imperfect technique and faulty interpretation of the pictures obtained lead to certain fallacies. In young subjects, for example, epiphysial lines may be mistaken for fractures, or the ossifying centres of epiphyses for separated fragments of bone. The os trigonum tarsi has been mistaken for a fracture of the astragalus. In the vicinity of joints the bones may be crossed by pale bands, due to the rays traversing the cavity of the joint. In this way fracture of the olecranon or of the clavicle may be simulated. The neck of the femur may appear to be fractured if a foreshortened view be taken.

It is possible, on the other hand, to overlook a fracture—for example, if there is no displacement, or if the line of fracture is crossed by the shadow of an adjacent bone. In deeply placed bones such as those about the hip, or in bones related to dense, solid viscera—for example, ribs, sternum, or vertebræ—it is sometimes difficult to obtain conclusive evidence of fracture in a radiogram.

It is to be borne in mind also, and especially from the medico-legal point of view, that, as early callus does not cast a shadow in a radiogram, the appearance of fracture may persist long after union has taken place. The disturbed perspective produced by the divergence of the rays may cause the fragments of a united fracture to appear displaced, although in reality they are in good position. If the limb and the plate are not parallel the bones may appear to be distorted, and errors in diagnosis may in this way arise.

As most of the remaining signs are common to all the lesions from which fractures have to be distinguished, their diagnostic value must be very carefully weighed.

*Interference with Function.*—As a rule, a broken bone is incapable of performing its normal function as a lever or weight-bearer; but when a fracture is incomplete, when the fragments are impacted, or when only one of two parallel bones is broken, this does not necessarily follow. It is no uncommon experience to find a patient walk into hospital with an impacted fracture of the neck of the femur or a complete fracture of the fibula; or to be able to pronate and supinate the forearm in the presence of a greenstick fracture of the radius or with a complete fracture of the ulna.

*Pain.*—Three forms of pain may be present in fractures: pain as such; pain induced by movement of the limb; pain elicited on pressure, or "tenderness," and pain independent of movement or pressure (John Duncan). In injuries by direct violence, pain as such is never diagnostic of fracture, as it may be due to bruising or tearing of soft tissues. In the region of a joint also, pain may be due to dislocation or sprain as well as to fracture. In injuries resulting from indirect violence, however, pain localised to a spot at some distance from the point of impact is strongly suggestive of fracture—as, for example, when a patient complains of pain over the clavicle after a fall on the hand, or over the upper end of the fibula after a twist of the ankle. Pain elicited by attempts to move the damaged part, or by applying pressure over the seat of injury, is more significant of fracture. Pain elicited at a particular point on pressing the bone at a distance, "pain on distal pressure," —for example, pain at the lower end of the fibula on pressing near its neck, or at the angle of a rib on pressing near the sternum—is a valuable diagnostic sign of fracture. When nerve trunks are implicated in the vicinity of a fracture, pain is often present along the course of their distribution.

*Localised swelling* comes on rapidly, and is due to displacement of the fragments, and effusion of blood.

*Discoloration* accompanies the swelling, and is often widespread, especially in bones near the surface and when the tension is great. It is not uncommon to find over the ecchymosed area, especially over the shin-bone, large dark blebs containing blood-stained serum. In fractures of deep-seated bones, discoloration may only show on the surface after some days, and at some distance from the break.

Alterations in the relative position of *bony landmarks* are valuable diagnostic guides. Alteration in the *length* of the limb, usually in the direction of shortening, is also an important sign. Before drawing deductions care must be taken to place both limbs in the same position and to determine accurately the fixed points for measurement, and also to ascertain if the limbs were previously normal.

*Shock* is seldom a prominent symptom in uncomplicated fractures, although in old and enfeebled patients it may be serious and even fatal. During the first two or three days after a fracture there is almost invariably some degree of traumatic *fever*, indicated by a rise of temperature to 99° or 100° F. (Fig. 12).

**Complications.**—*Injuries to large arteries* are not common

in simple fractures. The femoral, popliteal and tibial arteries, however, are liable to be compressed, punctured, or torn across in fractures of the bones with which they lie in close contact. Thrombosis, aneurysm, or gangrene of the limb may follow such injuries. If large *veins* are injured, venous thrombosis may occur and this may lead to pulmonary embolism.

*Injuries to nerve trunks* are comparatively common, especially in fractures of the upper arm, where the musculo-spiral, ulnar, or other branches of the brachial plexus are liable to suffer; and in fracture of the neck of the fibula, where the external popliteal may be involved.

The nerves may be implicated at the time of the injury, being compressed, bruised, lacerated, or completely torn across by broken fragments, or they may be involved later by becoming compressed by callus. The symptoms depend upon the degree of damage sustained by the nerve, and vary from partial and temporary interference with sensation and motion to complete and permanent abrogation of function.

*Suppuration and necrosis* are exceedingly rare sequelæ of simple fractures. *Fat embolism* sometimes occurs, and fat globules are found in the urine. *Delirium tremens* is a not infrequent accompaniment of fractures in persons addicted to alcohol.

**Prognosis in Simple Fractures.**—Danger to life in simple fractures depends chiefly on the occurrence of complications. In old people, when the injury necessitates long and continuous lying on the back, bronchitis, hypostatic pneumonia, and bed-sores are prone to occur. Gradually increasing debility and mental deterioration also cause anxiety in these cases. Fractures complicated with injury to internal organs, and fractures where gangrene threatens, are, of course, of grave import.

The prognosis as regards the function of the limb should always be guarded, even in simple fractures. Incidental complications are liable to arise, delaying recovery and preventing a satisfactory result, and these not only lead to disappointment, but may even form a ground for actions for malpraxis.

The character, direction, and extent of the fracture influence the prognosis, the best results usually following single and transverse breaks, while those which are multiple, comminuted, or oblique unite less rapidly and less satisfactorily.

Fibrous union is a common result in fractures of the neck of the femur in old people and in certain other fractures, such as fracture of the patella, of the olecranon, coronoid, and coracoid processes —a prospect of which the patient should be duly warned.

Impairment of growth and eventual shortening of the limb may result from involvement of an epiphysis in young persons (Fig. 125).

Stiffness of joints is liable to follow fractures implicating articular surfaces, or it may result from chronic arthritic changes induced by the injury.

True osseous ankylosis is not a common sequel of simple fractures, but locking of joints from the mechanical impediment produced by the union of imperfectly reduced fragments, or from masses of callus, is not uncommon, especially in the region of the elbow.

Wasting of the muscles from disuse, and œdema of the limb, often delay the complete restoration of function. Delayed union, want of union, and the formation of false joints will be referred to later.

**Treatment.**—The treatment of a fracture should be commenced as soon after the accident as possible, before the muscles become contracted and hold the fragments in abnormal positions, and before blood and serum are effused into the tissues and adhesions form.

Every care must be taken during the transport of the patient that no further damage is done to the injured limb. To this end the part must be secured in the best form of extemporised splint which the ingenuity of the surgeon and the surroundings of the patient can furnish, the apparatus being so designed as to control not only the broken fragments, but also the joints above and below the fracture.

When the ordinary method of removing the clothes involves any risk of unduly moving the injured part, they should be slit open along the seams.

The patient should be placed on a firm straw, horse-hair, or spring mattress, stiffened in the case of fractures of the spine, pelvis, or lower limbs, by strong wooden fracture-boards inserted between the mattress and the frame of the bed. Special mattresses constructed in four pieces, to facilitate the nursing of the patient, are sometimes used. Feather beds are to be avoided.

In many cases, particularly in very muscular subjects, in restless alcoholic patients, and in those who do not bear pain well, a general anæsthetic is a valuable aid to the rapid and accurate setting of a fracture, as well as a means of rendering the diagnosis more certain.

The procedure popularly known as "setting a fracture" consists in restoring the displaced parts to their normal position, and is spoken of technically as the *reduction* of the fracture.

After reduction has been effected appropriate means must be taken to retain the parts in position.

*The Reduction of a Fracture.*—In some cases the displacement may be completely overcome by relaxing the muscles acting upon the fragments. In most cases, however, it is necessary, after relaxing the muscles, to employ *extension*, by making forcible but steady traction on the distal fragment, while *counter-extension* is exerted on the proximal one, either by an assistant pulling upon that portion of the limb, or by the weight of the patient's body. The fragments having been freed, and any shortening of the limb corrected in this way, the broken ends are moulded into position—a process termed *coaptation.*

The reduction of a recent greenstick fracture consists in forcibly straightening the bend in the bone, and in some cases it is necessary to render the fracture complete before this can be done.

In certain cases of impacted fracture which will be specified later, it is not advisable to undo the impaction.

In selecting a means of retaining a fracture in position after its reduction, the various factors which tend to bring about re-displacement must be taken into consideration, and appropriate measures adopted to counteract each of these. Thus it may be that the fragments, being oblique, tend to glide past one another; that powerful muscles inserted into one of the fragments pull it away from its neighbour; that the weight of the distal portion of the limb causes it to fall in a particular direction in obedience to gravity; or that certain movements on the part of the patient determine displacement.

In addition to retaining the broken ends of the bone in apposition, the after-treatment of a fracture involves the taking of steps to promote the absorption of effused blood and serum, to maintain the circulation through the injured parts, and to favour the repair of damaged muscles and other soft tissues. Means must also be taken to maintain the functional activity of the muscles of the damaged area, to prevent the formation of adhesions in joints and tendon sheaths, and generally to restore the function of the injured part.

*Practical Means of Effecting Retention—By Position.*—It is often found that only in one particular position can the fragments be made to meet and remain in apposition—for example, the completely supine position of the forearm in fracture of the radius just above the insertion of the pronator radii teres. Again, in certain cases it is only by relaxing particular groups of muscles that the displacement can be undone—as, for instance, in fracture

of the femur immediately above the condyles, where flexion of the knee, by relaxing the calf muscles, permits of reduction.

*Massage and Movement in the Treatment of Fractures.*— Until within recent years fractures were invariably treated by complete immobilisation of the injured limb in a splint or other form of rigid apparatus, until firm osseous union had taken place. The result of the prolonged fixation of the limb was that in many cases the muscles became atrophied, adhesions formed in joints and tendon sheaths, the restoration of function was much delayed, and in some cases permanent stiffness resulted.

Lucas-Championnière, in 1895, was the first to advocate the treatment of fractures by massage and movement, and the discarding of rigid splints and other retentive appliances.

The measures adopted vary according to the nature and seat of the fracture, but in general terms it may be stated that after the fracture has been reduced, the ends of the broken bone are carefully retained in position by the hands of an assistant, and gentle massage is applied by the surgeon. The parts on the proximal side of the injured area are first gently stroked upwards to empty the veins and lymphatics, and to disperse the effused blood and serum. The rubbing process is then applied to the swollen area, and gradually extended down over the seat of the fracture and into the parts beyond. In this way the circulation through the damaged segment of the limb is improved, the veins are emptied of blood, and the removal of effused fluids is stimulated. The neighbouring joints are gently moved, and the patient is encouraged to contract the muscles voluntarily, care being taken all the while that the broken ends of the bone are not displaced. After the rubbing has been continued for from fifteen to twenty minutes, the limb is placed in a comfortable position, and retained there by pillows, sand-bags, or, if found more convenient, by a light form of movable splint. In fixing the limb in position it is necessary to avoid constricting it in any way that will interfere with the circulation.

The massage is repeated every day, the sittings being gradually extended to twenty or thirty minutes, while the rubbing and the movements are carried out more energetically as time proceeds. The patient is encouraged at each sitting to move his joints voluntarily and against resistance. After an interval varying with the nature of the fracture all retentive appliances may be removed, but the massage should be continued until consolidation of the callus is complete.

The value of this procedure is greatest in fractures in the

vicinity of joints, particularly the elbow, ankle, wrist, and knee. Not only is pain diminished, the formation of bony callus promoted and union thereby hastened, but the prolonged crippling stiffness which so often follows immobilisation in splints is avoided. The risk of redisplacement of fragments is only to be feared in oblique fractures in the shafts of long bones, such as the humerus, femur, or bones of the leg; but even in these situations, by careful fixation of the broken ends while the massage and movements are being carried on, any such ill effects can usually be obviated. Want of union, so far from being a special risk attending this method of treatment, is less liable to occur, if ordinary precautions are taken, than when splints alone are employed.

*Splints and other Appliances.*—The less complicated and specialised splints are the better. The appropriate splints for individual fractures and the method of applying them will be described later; but it may here be said that the general principle is that when dealing with a part where there is a single bone, as the thigh or upper arm, the splint should be applied in the form of a *ferrule* to surround the break; whereas in situations where there are two or more parallel bones, as in the forearm, leg, metatarsus, or metacarpus, the splint should take the form of a *box* (Fig. 98).

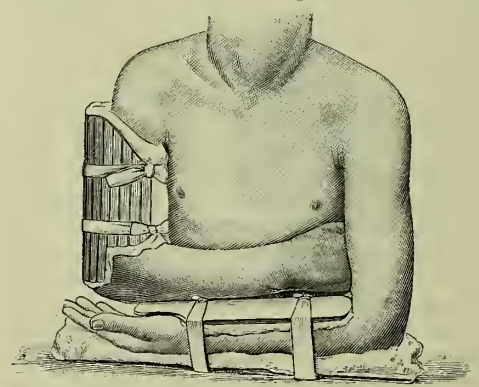


Fig. 98.—Gooch Splint applied as a "Ferrule" on Right Upper Arm, as a "Box" on Left Forearm.

*Simple wooden splints* of plain deal board or yellow pine, sawn to the appropriate length and width; or *Gooch's splinting*, which consists of long strips of soft wood, glued to a backing of wash leather, are the most useful materials for splints. Gooch's splinting has the special advantage that when applied with the leather side next the limb it encircles the part as a ferrule; while it remains rigid when the wooden side is turned towards the skin (Fig. 98). Perforated sheet lead or tin, stiff wire netting, and hoop iron also form useful splints.

When it is desirable that the splint should take the shape of the part accurately, a plastic material may be employed. Perhaps the most convenient is *poroplastic felt*, which consists of strong felt saturated with resin. When heated before a strong fire or placed in boiling water, it becomes quite plastic, and may be accurately moulded to any part, and on cooling again becomes rigid. The splint should be cut from a carefully

fitted paper pattern. Millboard, leather, or gutta-percha softened in hot water, and moulded to the part, may also be employed.

In military practice, and in other conditions where treatment by massage and movement is impracticable, and where movable splints are inconvenient, splints of *plaster of Paris*, *starch*, or *water-glass* are sometimes used, especially in the treatment of fractures of the leg. When employed in the form of an immovable case they are open to certain objections — for example, if applied immediately after the accident they are apt to become too tight if swelling occurs; and if applied while swelling is still present, they become slack when this subsides, so that displacement is liable to occur.

When it is desired to enclose the limb in a plaster case, coarse muslin bandages, three yards long, and charged with the finest quality of thoroughly dried plaster of Paris, are employed. The "acetic plaster bandages" sold in the shops set most quickly and firmly. A boracic lint bandage is evenly applied next the skin, and the bony prominences are specially padded. The plaster bandage is then placed in cold water till it is thoroughly saturated, and after the excess of water is squeezed out of it, is applied in the usual way from below upward. From four to six plies of the bandage are required. In the course of half-an-hour the plaster should be thoroughly set. In order to remove a plaster case the limb should be immersed for a short time in tepid water.

*Croft's splint*, or some modification of it, is perhaps the best form of movable plaster splint. It is made by accurately shaping *two* pieces of thoroughly shrunk house-flannel to *each* side of the limb, and immersing one of each pair in a solution of plaster of Paris of the consistence of thin cream till the flannel is thoroughly impregnated. The dry pieces are placed next the skin, with the saturated pieces over them, and a coarse gauze bandage is then applied to fix them in position. After the plaster has set, if it is desired to remove the splint for the purpose of employing massage, the gauze bandage is cut along the front of the limb, and the splint opened out on the hinge formed by the posterior turns of the bandage.

A most convenient and efficient splint is made by moulding two pieces of poroplastic felt to the sides of the limb, and fixing it in position with an elastic webbing bandage.

*Padding* is an essential adjunct to all forms of splints. The whole part enclosed in the splint must be covered with a thick layer of soft and elastic material, such as cotton wool or lint. All hollows should be filled up, and all bony projections specially protected by rings of wadding so arranged as to take the pressure off the prominent point and distribute it on the surrounding parts. Opposing skin surfaces must always be separated by a layer of cotton wool or boracic lint. A bandage should never be applied to the limb underneath the splints and pads, as congestion or even gangrene may be induced thereby.

**Operative Treatment of Simple Fractures.**—In certain cases it is found impossible to bring the fragments into accurate apposition or to retain them there. This may be due to the obliquity of the fracture, as, for example, in the bones of the leg; to the interlocking of fragments, as occurs frequently in epiphysial separations; to the traction of powerful muscles on one of the fragments, as in fracture of the patella or olecranon;

or to the interposition of soft tissues between the broken ends. Under such circumstances it may be necessary to expose the fracture by operation, and after reducing it, to fix the fragments together by wires, pegs, staples, or screws. Operative interference is usually delayed till about a week after the injury, by which time the effect of other measures will have been estimated, and accurate information obtained by means of the X-rays regarding the nature of the lesion and the position of the fragments. Such operations, however, are not to be undertaken lightly, as they are difficult, and if septic infection takes place the results may be disastrous. Consolidation of the fragments takes place more slowly when the ends have been brought together by operation than in subcutaneous fractures.

### Compound Fractures.

The characteristic feature of a compound fracture is the existence of an open wound leading down to the break in the bone, and it is the presence of the wound which, by providing a means of entrance for bacteria, dominates the whole aspect of the case. The wound may vary in size from a mere puncture to an extensive ragged tear of all the soft parts.

A fracture may be rendered compound *from without*, the soft parts being damaged by the object which breaks the bone—as, for example, a cart wheel, a piece of machinery, or a bullet. Sloughing of soft parts resulting from the pressure of improperly applied splints also, may convert a simple into a compound fracture. On the other hand, a simple fracture may be rendered compound *from within*—for example, a sharp fragment of bone may penetrate the skin, or the skin may slough as a result of extreme tension from effused blood.

As a rule it is easy to recognise that the fracture is compound, as the bone can either be seen or felt through the wound. When any doubt exists as to whether or not a wound communicates with the bone, it is safer to enlarge it by incision than to assume that the fracture is simple.

The *prognosis* depends on the success which attends the efforts to make and to keep the wound aseptic, as well as on the extent of damage to the tissues. When sepsis ensues, fragments of bone may undergo necrosis and lead to the formation of sinuses, and union is usually attended with excessive and irregular callus formation (Fig. 104).

*Treatment.*—The leading indication is to ensure asepsis of the wound. Even in the case of small punctured wounds

caused by a pointed fragment coming through the skin, it is never wise to assume that the wound is not infected. It is much safer to enlarge such a wound, pare away the bruised edges, and disinfect the raw surfaces.

In cases of extensive laceration of the soft parts, all soiled, bruised, or torn portions of tissue should be clipped away with scissors, blood-clots removed, and the bleeding arrested by forci-pressure or ligature. When there is good reason to believe that the wound is not already infected, any fragments of bone completely separated from the periosteum may be left; but when there is any suspicion of infection they had better be removed. The wound should then be washed out with sterilised salt solution. On the whole, it is safer not to attempt to obtain primary union by completely closing such wounds, but rather to drain or partially pack them, counter-openings being made at dependent points if necessary.

In other respects the treatment of compound fractures is carried out on the same lines as in simple fractures, provision being made for dressing the wound, without undue disturbance of the bones. Massage and movement should be commenced after the wound is healed and the condition has become analogous to a simple fracture.

**Question of Amputation in Compound Fractures.**—Before deciding to perform primary amputation of a limb for compound fracture the surgeon must satisfy himself (1) that the attainment of asepsis is impossible; (2) that the soft parts are so widely and so grossly damaged that their recovery is improbable; (3) that the vascular and nervous supply of the parts beyond has been rendered insufficient by destruction of the main blood-vessels and nerve trunks; (4) that the bones have been so shattered as to be beyond repair; and (5) that the limb, even if healing takes place, will be less useful than the stump resulting after a suitable amputation.

In attempting to save the limb of a young subject it is justifiable to run risks which would not be permissible in the case of an older person. To save an upper limb, also, risks may be run which would not be justifiable in the case of a lower limb, because, while a serviceable artificial leg can readily be procured, any portion of the natural hand or arm is infinitely more useful than the best substitute which the instrument-maker can contrive. The risk involved in attempting to save a limb should always be explained to the patient or his friends, in order that they may share the responsibility in case of failure.

Whether or not the amputation should be performed at once depends upon the general condition of the patient. If the injury is a severe one, and attended with a profound degree of shock, it is better to wait for twenty-four or forty-eight hours. Meanwhile the wound is thoroughly purified, and the limb wrapped in an antiseptic dressing. Means are taken to counteract shock and to maintain the patient's strength, and evidence of septic infection or of hæmorrhage is carefully watched for. When the shock has passed off and the patient is able to stand the operation, it is then performed under more favourable auspices. Clinical experience proves that by this means the mortality of primary amputations may be materially diminished, especially in injuries necessitating removal of an entire limb.

Having decided to amputate, it is important to avoid having bruised, torn, or separated tissues in the flaps, as these are liable to slough or to become the seat of septic infection. In this connection it should be borne in mind that the damage to soft tissues is always wider in extent than appears from external examination.

Amputation may be called for later to arrest spreading septic processes, osteo-myelitis, or gangrene; to prevent exhaustion from prolonged suppuration and septic absorption; or on account of secondary hæmorrhage.

## SEPARATION OF EPIPHYSES.

It is only within late years that the subject of the separation of epiphyses (or, as they are sometimes called, *diastases*[1]) has received its due share of attention, and the use of the X-rays has added greatly to our knowledge of these lesions.

It is useful to remember, that in the upper extremity, the epiphyses in the regions of the shoulder and wrist, and, in the lower extremity, those in the region of the knee, are the latest to unite; and that it is in these situations that growth in length of the bone goes on longest and most actively. Injuries of these epiphyses, therefore, are most liable to interfere with the growth of the limb.

An epiphysis is nourished from the articular arteries and through the vessels of the periosteum.

[1] The term "diastasis" has been employed in different senses by different writers.

*Pathological Separation of Epiphyses.*—There are certain pathological conditions, such as rickets, scurvy, congenital syphilis, tubercle, suppurative conditions, and tumour growths, which render separation of epiphyses liable to occur from injuries altogether insufficient to produce such lesions under normal conditions.

**Traumatic Separations.**[1]—Speaking generally, it may be said that injuries which in an adult would be liable to produce dislocation, are in a young person more apt to cause separation of an epiphysis. Indirect violence, especially when exerted in such a way as to combine traction with torsion, for example, when the leg is caught in the spokes of a carriage wheel, is the commonest cause of epiphysial separation. Direct violence is a much less frequent cause. Muscular action occasionally produces separation of such epiphyses as the anterior-superior iliac spine, the lesser trochanter of the femur, or the upper fibular epiphysis.

It would appear that the majority of separations take place between the eleventh and the eighteenth years, chiefly because during this period the injuries liable to produce such lesions are most prone to occur. They do not occur after twenty-five, because by that time all the epiphyses have united. In females this form of injury is rare, and almost invariably occurs before puberty.

The following are the most common seats of separation in the order of their frequency:—(1) The lower end of the femur; (2) the lower end of the radius; (3) the upper end of the humerus; (4) the lower end of the humerus; (5) the lower end of the tibia; and (6) the upper end of the tibia.

*Morbid Anatomy.*—In a true separation the epiphysial cartilage remains attached to the epiphysis. As a rule the epiphysis is not completely separated from the diaphysis, the common lesion being a separation along part of the epiphysial line, with a fracture running into the diaphysis (Fig. 100). It is not uncommon for more than one epiphysis to be separated by the same accident—for example, the lower end of the femur and the upper ends of the tibia and fibula. Like fractures, epiphysial separations may be *simple* or *compound*. Incomplete separations are liable to be overlooked at the time of the accident, but there is reason to believe that they may form the starting-point of various diseases of bones and joints. Strain of the epiphysial junction—the *juxta-epiphysial strain* of Ollier—is a common injury in young children.

[1] We desire here to acknowledge our indebtedness to Mr. John Poland's work on *Traumatic Separation of the Epiphyses.*

*Clinical Features.*—The symptoms simulate those of dislocation rather than of fracture. Thus, *unnatural mobility* at an epiphysial

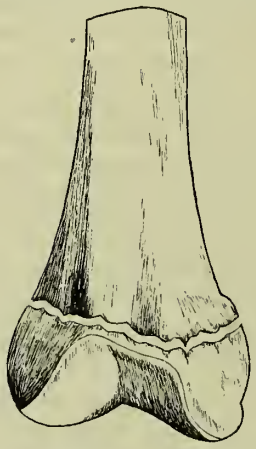


FIG. 99.—Complete Separation of Epiphysis.



FIG. 100.—Partial Separation of Epiphysis, with Fracture running into Diaphysis.

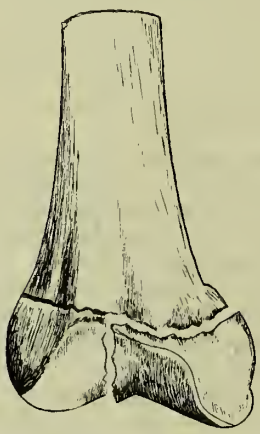


FIG. 101.—Partial Separation with Fracture of Epiphysis.



FIG. 102.—Complete Separation with Fracture of Epiphysis.

junction may closely resemble movement at the adjacent joint, especially when the epiphysis is an intracapsular one. The

relationship of the bony points, however, serves to indicate the nature of the lesion. The degree of *deformity* is often slight, because of the transverse direction of the lesion, the breadth of the separated surfaces, and the firmness of the periosteal attachment along the epiphysial line. In many cases a distinct, rounded, smooth, and regular ridge, caused by the projection of the diaphysis, can be felt (Fig. 190). The peculiar "muffled" nature of the *crepitus* is one of the most characteristic signs. The older the patient, and the further ossification has progressed, the more does the crepitus resemble that of fracture.

Of the subsidiary signs, *loss of power* in the limb is one of the most constant; indeed, in young children it is sometimes the first, and may be the only sign which attracts attention. *Pain* and *tenderness* along the epiphysial line are valuable signs, particularly when the lesion is due to indirect or muscular violence and there is no bruising of soft parts. Localised *swelling*, accompanied by *ecchymosis*, is often marked; and the adjacent joint may be distended with fluid.

As distinguishing this injury from a dislocation, it may be noted that in epiphysial separation there is no snap felt when the deformity is reduced, the tendency to re-displacement is greater, and the amount of relief given by reduction less than in dislocation.

The use of the Röntgen rays at once establishes the diagnosis.

*Prognosis and Results.*—In the great majority of cases union takes place satisfactorily by the formation of callus in the spongy tissue of the diaphysis and on the inner surface of the periosteum.

In spite of the favourable nature of the prognosis in general, however, the friends of the patient should be warned that a completely satisfactory result cannot always be relied upon.

Deformity, and impairment of movement at the adjacent joint may result from imperfect reduction, from exuberant callus, or from adhesions. Arrest of growth of the bone in length is a rare sequel, and when it occurs, it is due, not to premature union of the epiphysis with the shaft, but to diminished action at the ossifying junction.

When the growth of one of the bones of the leg or forearm is arrested after separation of its epiphysis while the other bone continues to grow, the foot or hand is deviated towards the side of the shorter bone.

*Treatment.*—The general principles which govern the treatment

of fractures apply equally to epiphysial separations, and the special points will be described with the individual lesions.

### Repair of Injuries of Bone.

In a *simple fracture*, the vessels of the periosteum and the marrow being torn at the same time as the bone is broken, a blood-clot forms around and between the fragments. This clot is soon permeated by newly formed blood-vessels, and by leucocytes and fibroblasts, the latter being derived from proliferation of the cells of the marrow and periosteum. The granulation tissue thus formed resembles in every particular that described in the repair of other tissues, except that the fibroblasts, being the offspring of cells which normally form bone, assume the functions of *osteoblasts*, and proceed to the formation of new bone. The bone may be formed either by a direct conversion of the fibrous tissue into osseous tissue, the osteoblasts arranging themselves concentrically in the recesses of the capillary loops, and secreting a homogeneous matrix in which lime-salts are speedily deposited; or there may be an intermediate stage of cartilage formation, especially in young subjects, and in cases where the fragments are not completely immobilised. The newly formed bone is at first arranged in little masses or in the form of rods which unite with each other to form a network of spongy bone, the meshes of which contain marrow.

The reparative material, consisting of granulation tissue in the process of conversion into bone, is called *callus*, on account of its hard and unyielding character. In a fracture of a long bone, that which surrounds the fragments is called the *external* or *ensheathing callus*, and may be likened to the mass of solder which surrounds the junction of pipes, in plumber-work (Fig. 103); that which occupies the position of the medullary canal is called the *internal* or *medullary callus*; and that which intervenes between the fragments and maintains the continuity of the cortical compact tissue of the shaft is called the *intermediate callus*. This intermediate callus is the only permanent portion of the reparative material, the external and internal callus being only temporary, and being largely reabsorbed through the agency of giant cells.

Detached fragments or splinters of bone may be absorbed, or they may be included in the callus and ultimately become incorporated in the new bone which bridges the gap.

All surplus bone is removed, the medullary canal is re-formed,



FIG. 103.—Radiogram of Fracture of Ulna, two months after injury, to show Callus. The patient had perfect use of his arm for his work as a labourer six weeks after the accident.

(Mr. J. W. Struther's case).
Radiogram by Dr. F. K. Kerr.

the young spongy bone of the intermediate callus becomes more and more compact, and thus the original architectural arrangement of the bone may be faithfully reproduced.

The amount of callus produced in the repair of a given fracture is greater when movement is permitted between the broken ends. It is also influenced by the character of the bone involved, being less in bones entirely ossified in membrane, such as the flat bones of the skull, than in those primarily ossified in cartilage.

If the fragments are widely separated from one another, or if some tissue, such as muscle, intervenes between them, callus may not be able to bring about a bony union between the fragments, and *non-union* results.

Bones divided in the course of an operation, for example in osteotomy for knock-knee, or wedge-shaped resection for bow-leg, are repaired by the same process as fractures.

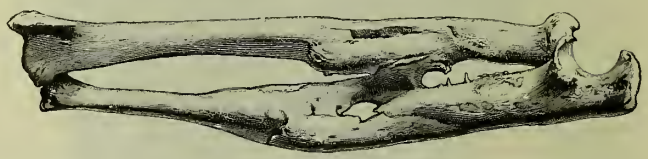


Fig. 104.—Excessive Callus Formation after Septic Compound Fracture of both Bones of Forearm—result of gun-shot wound. Fusion of Bones across Interosseous Space.

*A compound fracture*, if not infected by bacteria, heals in the same way as a simple one. Should infection ensue, however, changes associated with inflammation complicate the healing process and give rise to phenomena which will be referred to with the diseases of bone. Under these circumstances any fragments which may have been detached are liable to undergo necrosis, and to require removal.

**Excess of Callus.**—In comminuted fractures, and in fractures where there is much displacement, the amount of callus is in excess, but this is necessary to ensure stability. In fractures in the vicinity of large joints, such as the hip or elbow, the formation of callus is sometimes excessive, and the projecting masses of new bone restrict the movements of the joint. When exuberant callus forms between the bones in fractures of the forearm, pronation and supination may be interfered with (Fig. 104). Certain nerve trunks, such as the musculo-spiral in the middle of the upper arm, or the ulnar at the elbow-joint, may become included in or pressed upon by callus.

**Badly United Fracture — Mal-Union.**—Bony union with marked displacement of the fragments is most common in fractures which have not been properly treated—as, for example, those occurring in sailors at sea; and in cases where the comminution was so great that accurate apposition was rendered impossible. It may also result from imperfect reduction, or because the apparatus employed permitted of secondary displacement. Restlessness on the part of the patient from intractability, delirium tremens, or mania, is the cause of vicious union in some cases.

Whether or not any attempt should be made to improve matters depends largely on the degree of deformity and the amount of interference with function.

While the fracture is still recent, the bone may be bent into position or rebroken under an anæsthetic, and set accurately. When the callus is firmly consolidated, a strong mechanical contrivance, known as an osteoclast, may be employed to rebreak it, but in the majority of cases an osteotomy with chisel and mallet gives results which are more certain and satisfactory. In the milder cases, the bone may be divided with an osteotome and straightened; while in those with more marked bending or angling, a wedge may be taken from the convexity, as in the operation for bow-leg. To retain the fragments in position, splints and extension may be employed; or if these measures are insufficient, pegs, screws, bone ferrules, or other direct means may be used.

**Delayed Union.**—The normal period required for union may be extended from various causes. The most important of these is general debility, but the presence of rickets or tuberculosis, or an intercurrent acute infectious disease, may help to delay the reparative process. The influence of syphilis, except in its gummatous forms, in interfering with union is doubtful. The influence of old age as a factor in delaying union has been overestimated; in the great majority of cases, fractures in old people unite as rapidly and as firmly as those occurring in middle life. At the time when union should be firm and solid it may be found that the fragments are only united by a soft cartilaginous callus, which for a prolonged period may undergo no further change, so that the limb remains incapable of bearing weight or otherwise performing its functions.

*Treatment.*—In such cases the general condition of the patient should be improved as far as possible by dieting and tonics. One of the most reliable methods of hastening union in these cases is by inducing passive congestion of the limb after

the method advocated by Bier, and this plan should always be tried in the first instance. An elastic bandage is applied above the seat of fracture, sufficiently tightly to congest the limb beyond, and, to concentrate the congestion in the vicinity of the fracture, an ordinary bandage should be applied from the distal extremity to within a few inches of the break. The congestion should be maintained for several hours (six to twelve) daily. An accurately fitting apparatus should be adjusted to enable the patient to get into the open air. This method of treatment should be persevered with for three or four weeks, and the limb should be massaged daily while the bandage is off.

Among the other methods which have been recommended are the injection of oil of turpentine between the fragments (Mikulicz); the forcible rubbing of the ends together, under an anæsthetic if necessary; and the administration of thyroid extract. If these methods fail, the parts may be exposed by operation, and the ends of the bones rawed, and pegged or wired. As a rule satisfactory union is ultimately obtained, although much patience is required.

**Want of Union—"Un-united Fracture."**—In a few cases union entirely fails to take place, and the condition is spoken of as an un-united fracture. The most common local cause of non-union is the interposition of a portion of muscle, tendon, or other soft tissue between the ends of the bones. This is most liable to occur in oblique fractures with overlapping of the fragments, and it may be suspected if, with the X-rays, a clear space is seen between the fragments.

Any interference with the circulation of the limb, and any form of bacterial infection leading to suppuration in the region of the fracture, is liable to lead to non-union. Fractures inside the capsule of a joint, for example, the hip or shoulder, may also fail to unite, probably because the short fragment has but a poor vascular supply, and because it is impossible to maintain accurate apposition of the fragments.

The fragments become atrophied, the ends rounded, and the medullary cavity obliterated, and the ends of the bone remain separate and freely movable. The whole limb may share in this atrophy. In adults, this is most frequently met with in the humerus and in the femur, and in most cases union may be brought about by operative measures. In children, it is occasionally met with in the bones of the leg, and is seldom, if ever, cured by operation. The lower fragments in these cases become very small and thin, and the limb is so useless that amputation is usually necessary.

*Treatment.*—If it has not already been tried, the usual treatment for delayed union should be instituted, and if this fails recourse must be had to operation. The parts having been rendered bloodless, an incision is made to expose the fragments freely, and after removal of any intervening material and rawing of their surfaces, nails or wires are inserted to secure accurate apposition. The use of aluminium plates fixed to the bone by screw-nails is sometimes a more efficient means of keeping the fragments in position. In certain cases dove-tailing the ends into one another, grafting bone, or enclosing the fragments in a ferrule of decalcified bone has been successful.

**Fibrous Union.**—Sometimes dense fibrous tissue forms between the fragments, constituting *fibrous union*. When the fragments are widely separated, as in the patella or olecranon; when a large segment of a bone is shattered and the fragments lost, as in some compound fractures; or when a sequestrum forms between the fragments, osseous union is obviously impossible, and fibrous union all that can be hoped for.

**False Joint.**—This is merely an exaggerated form of defective union. The ends of the bones become rounded, polished, and covered with a layer of cartilage. A firm capsule of fibrous tissue, lined by a layer of endothelium, secreting synovia-like fluid, binds them together and forms a veritable joint.

*Treatment* is carried out on the same lines as for non-union, the pseudarthrosis being excised before the ends are fixed in apposition.

*Absorption of Callus.*—Sometimes during an attack of some acute infective disease, especially one of the exanthemata, it may be weeks or even months after union has taken place, well-formed callus may be softened and absorbed.

*Tumours of Callus.*—Tumours, such as chondromata and sarcomata, are liable to occur in callus, or at the seat of old fractures, but the evidence so far is inconclusive as to the causal relationship of the injury to the new growth. They are treated on the same lines as tumours occurring independently of fracture.

# CHAPTER XXI.

## INJURIES OF JOINTS.

SURGICAL ANATOMY—INJURIES: *Contusions; Wounds; Sprains; Dislocations*—TRAUMATIC DISLOCATIONS: *Causes; Varieties; Clinical features; Treatment*—Compound dislocations—Old-standing dislocations.

**Surgical Anatomy.**—The function of a joint is to permit of the movement of one bone upon another. The articular surfaces of the bones are covered with a thin layer of hyaline cartilage, and are retained in apposition by the tension of ligaments and of the muscles surrounding the joint. The capsular ligament encloses the articular ends of the bones, and is directly continuous with the periosteum. The capsule is lined by synovial membrane, which at the line of attachment of the ligament is reflected on to the bone as far as the articular cartilage. The synovial membrane invests intra-articular ligaments, and is projected into the interior of the joint in the form of loose folds wherever the articulating surfaces are not in immediate contact. The surface of the membrane is covered with minute processes or villi, which in diseased conditions may become hypertrophied. The synovia owes its lubricating property to mucin, derived from the solution of the endothelial cells on the free surface of the membrane. The opposing surfaces of a joint being always in accurate contact, the so-called cavity is only a potential one. If fluid is poured out into the joint, the synovial membrane and the capsule are put upon the stretch, causing discomfort or actual pain, which is partly relieved by slightly flexing the joint. If the distension continues, the ligaments become elongated and the joint unstable.

The common origin of bone, cartilage, periosteum, and synovial membrane from one parent tissue of the embryo, accounts for the readiness with which any one of these tissues may be converted into another under traumatic or pathological influences.

Joints derive an abundant blood-supply through the articular arteries. The lymphatics, which take origin in the synovial membrane, pass to efferent vessels which run in the intermuscular and other connective-tissue planes of the limb. The nerve-supply is derived chiefly from the nerves distributed to the muscles acting on the joint and to the skin over it.

**Sources of Joint Strength.**—The capacity of a joint to resist dislocation depends upon (1) the shape of its osseous elements; (2) the strength

and arrangement of its ligaments; (3) the support it receives from muscles or tendons placed in relation to it; and (4) the relative stability of adjacent structures. While all these factors contribute to the strength of a given joint, one or other of them usually predominates, so that certain joints are osseously strong, others are ligamentously strong, while a few depend chiefly upon adjacent muscles for their stability.

The hip and elbow are the best examples of joints deriving their strength mainly from the architectural arrangement of the constituent bones. These joints are dislocated only by extreme degrees of violence, and not infrequently—especially in the elbow—portions of the bones are fractured before the articular surfaces are separated.

The wrist, the carpal, the tarsal, and the clavicular joints, depend for their stability almost entirely on the strength of their ligaments. These joints are rarely dislocated, but as the main incidence of the violence falls on the ligaments they are frequently sprained. The knee also is a ligamentously strong joint, and is further strengthened by its intra-articular ligaments.

The shoulder is the typical example of a joint depending for its security chiefly upon the muscles and tendons passing over it, and hence the frequency with which it is dislocated. At the same time the great mobility of the scapula and clavicle materially increase the stability of the shoulder-joint. It is probable that the tendons passing in relation to the knee, ankle, and wrist materially add to the stability of these joints.

The proximity of an easily fractured bone also contributes to prevent dislocation of certain joints—for example, fracture of the clavicle prevents an impinging force expending itself on the shoulder-joint; and the frequency of Colles' fracture of the radius, and of Pott's fracture of the fibula, doubtless accounts to some extent for the rarity of dislocation of the wrist and ankle joints respectively. The immunity from dislocation which the joints of young subjects enjoy is partly due to the ease with which the adjacent epiphyses are separated.

The mechanical axiom that "what is gained in movement is lost in stability" is true of joints, those joints which have the widest range of movement being the most frequently dislocated.

The injuries to which a joint is liable are Contusions, Wounds, Sprains, and Dislocations.

**Contusions of Joints.**—Contusion is the mildest form of injury to a joint. Whether the violence is transmitted from a distance, as in contusion of the hip from a fall on the feet, or acts more directly, as in a fall on the great trochanter, the bones are violently driven against one another, and the force expends itself on their articular surfaces. The articular cartilages and the underlying spongy bone, as well as the synovial membrane, are bruised, and there is an effusion of blood and serous fluid into the joint and surrounding tissues.

The most prominent *clinical features* are swelling and discoloration. The swelling, especially in superficially placed joints, is an early and marked symptom, and is mainly due to the effusion of blood into the joint (*hæmarthrosis*). In

deeply placed joints discoloration may not appear on the surface for some days, especially if the violence has been indirect. The joint is kept in the flexed position, and is painful only when moved. Considerable effusion of blood into a joint may follow the most trivial injury in hæmophilic subjects.

The *prognosis*, as a rule, is good, although a slight degree of serous effusion into the joint (*hydrarthrosis*) often persists for some time. Tuberculous affections of joints not infrequently date from a contusion.

*Treatment.*—When seen immediately after the accident, effusion may be prevented by applying firm pressure with an elastic bandage over a thick layer of cotton wool. After a few hours, massage and movement of the joint are commenced, and systematically and persistently employed. When effusion has already taken place and there is so much fluid in the joint as to interfere with movement, absorption may be promoted by withdrawing some of the fluid by means of an exploring needle, after which massage and movement are begun. Prolonged rest is to be avoided, as it results in stiffness and impaired or delayed usefulness.

**Wounds of Joints.**—The importance of accidental wounds of joints—such, for example, as result from a stab with a penknife or the point of a railing—lies in the fact that they are liable to cause septic infection of the synovial cavity. The inflammation may affect only the synovial membrane (*septic synovitis*); or may spread to all the elements of the joint (*septic arthritis*). These conditions are described with diseases of joints.

Penetration of the joint may sometimes be recognised by the escape of synovia from the wound, or by the synovial membrane or articular cartilage being exposed. When doubt exists, the wound should be enlarged. The use of the probe is to be avoided, on account of the risk of carrying septic material from the track of the wound into the cavity of the joint.

Penetrating wounds of joints are treated on the same lines as those associated with compound fractures. After having been disinfected, the wound should be drained or treated by the open method, and as soon as it is healed, massage and movement must be employed to prevent the formation of adhesions.

**Gun-shot injuries** of joints have already been described (p. 228).

**Sprains.**—A sprain results from a stretching or twisting form of violence which causes the joint to move beyond its physiological limits, or in some direction for which it is not

structurally adapted. The main incidence of the force therefore falls upon the ligaments, which are suddenly stretched or torn. The synovial membrane also is torn, and the joint becomes filled with blood and serum.

Muscles and tendons passing over the joint may be stretched or torn, and their sheaths filled with serous effusion. It is not uncommon for superficial portions of bone to be torn off at the site of attachment of strong ligamentous bands or tendons, constituting a "sprain fracture"; or for intra-articular cartilages to be displaced, as in the knee.

*Clinical Features.*—The injury is accompanied by intense sickening pain, and this may persist for a considerable time. At first it is aggravated by moving the joint, but if the movement is continued it tends to pass off. The particular ligaments involved may be recognised by eliciting tenderness on making pressure over them, or by putting them on the stretch by passively moving the joint. In this way a sprain may often be diagnosed from a fracture.

The effusion of blood and serum into the joint and into the tissues around gives rise to swelling and discoloration, and there is tenderness on pressing the articular surfaces together. Fluid effused into tendon sheaths often produces a peculiar creaking sensation, which may be mistaken for the crepitus of fracture. In sprains, the bony points about the joint retain their normal relations to one another, and this usually enables these injuries to be diagnosed from dislocations, and, as a rule, from fractures. When the swelling is great, it is often necessary to have recourse to the Röntgen rays to make certain that there is no fracture or dislocation.

*Prognosis.*—Stiffness, lasting for a longer or shorter time, follows most sprains, but may be largely prevented by proper treatment. In old and rheumatic persons changes of the nature of arthritis deformans are liable to supervene, interfering greatly with movement. While suppuration is rare, tuberculous disease not infrequently dates its onset from a sprain.

*Treatment.*—Sprains are best treated by early massage and movement, combined with firm elastic pressure. In the case of the ankle, for example, massage should be commenced at once, the part being gently stroked upwards. The process is painful for the first few minutes, but soon ceases to be so, and becomes soothing to the patient. The rubbing is continued for from fifteen to twenty minutes, the patient being encouraged to move the toes and ankle. A moderately firm elastic bandage or a few strips of adhesive plaster are then applied, care being taken not

to constrict the limb and so interfere with the circulation. The massage is repeated once or twice a day, the sittings lasting for about half an hour. The patient should be encouraged to move the joint from the first, beginning with the movements which put least strain upon the damaged ligaments, and gradually increasing the range. In the course of a few days he is encouraged to walk, or cycle, or otherwise to use the joint without subjecting it to strain. Alternate hot and cold douching, followed by massage, is also useful. Complete rest and prolonged immobilisation are to be condemned.

### Traumatic Dislocations.

A dislocation or luxation is a persistent displacement of the opposing ends of the bones forming a joint. We are here concerned only with such dislocations as immediately follow upon injury. Those which are congenital or which result from disease will be studied later.

*Causes.*—The majority of dislocations are the result of *indirect* violence, the more movable bone acting as a lever, on a fulcrum furnished by the natural check to movement in the form of ligament, bone, or muscle. It is in this way that most dislocations of the shoulder, hip, and elbow are produced.

At the moment the violence is applied, the muscles are relaxed or otherwise taken at a disadvantage, so that the joint is for the time being deprived of their support. The joint is moved beyond its physiological range, and the end of one of the bones being brought to bear upon the capsule, tears it, and passes through the rent thus made. The muscles then contract reflexly and pull the head of the bone into an unnatural position outside the capsule. The position assumed will depend upon such factors as the direction of the force, the shape of the joint, the position of the limb at the time of the accident, and the relative strength of the different groups of muscles acting upon the bone which is displaced.

Violence applied *directly* to the joint is a much less frequent cause of dislocation. In this way, however, the knee-joint may be dislocated, one bone being driven past the other—for example, by a kick from a horse; or the acromio-clavicular joint by a blow on the shoulder.

*Muscular contraction* is not often the sole cause of dislocation, although, as has been mentioned, it plays an important *rôle* in the production of the majority of these injuries. The shoulder, lower jaw, and patella are, however, not infrequently

displaced by muscular action alone. Some acrobats are able to dislocate certain joints by voluntary contraction of their muscles.

*Age and Sex.*—Dislocations occur most frequently in males and during adult life, doubtless on account of the nature of their occupations and recreations. In children the epiphyses are separated, and in old people the bones are broken, by such forms of violence as cause dislocation in adults.

Muscular debility and undue laxness of ligaments resulting from disease or previous dislocation are also predisposing factors.

*Clinical Varieties.*—The separation between the bones may be *complete* or *partial*. When partial, portions of the articular surfaces remain in apposition, and the injury is known as a *sub-luxation*. Like fractures, dislocations may be *simple* or *compound*, the latter being specially dangerous on account of the risk of septic infection. When seen within a few days of its occurrence, a dislocation is looked upon as *recent*; but when several weeks or months have elapsed, and the rent in the capsule has healed round the neck of the bone, it is spoken of as an *old-standing* dislocation. The latter will be described on p. 438.

Dislocations, like fractures, may be *complicated* by injuries to large blood-vessels or nerve trunks, by injuries to internal organs, or by a wound of the soft tissues which does not communicate with the joint. Further, a fracture may coexist with a dislocation.

*Clinical Features.*—The most characteristic signs of dislocation are *preternatural rigidity*, or want of movement where movement should naturally take place, following immediately on an injury; and *deformity*, the part being "out of drawing" as compared with the uninjured side (Fig. 115). The deformity is characteristic and is common to all examples of the same dislocation. The bony landmarks lose their normal relationship to one another. The relationship of the long axis of the bone to the socket is also abnormal.

Although any of the subsidiary signs may occur in lesions other than dislocations, due weight must be given to them in making a diagnosis. *Loss of function* is complete as a rule. *Pain* is much more intense than in fracture, usually because the displaced bone presses upon nerve trunks, and from the same cause there is often numbness and partial paralysis of the limb beyond. *Swelling* of the soft parts due to effused blood is usually less marked in dislocation than in fracture, but is often sufficiently great to interfere with diagnostic manipulations.

The displaced bone, and sometimes the empty socket, may be palpable. *Discoloration* is usually later of appearing than in fractures. *Alteration in the length* of the injured limb—usually in the direction of shortening—is a very constant feature; while girth measurements commonly show an increase. A peculiar soft *grating* or *creaking sensation* is often felt on attempting to move the joint. This is due to cartilaginous or ligamentous structures rubbing on one another, and must not be mistaken for the crepitus of fracture. When the dislocation has been reduced, in the great majority of cases although not in all, the bones retain their proper relations without external support. A careful investigation of the kind of force which produced the injury, particularly as regards its intensity and direction of action, may aid in the diagnosis. The diagnosis can always be verified by the use of the Röntgen rays, and this should be had recourse to whenever possible.

*Prognosis.*—After having once been dislocated, a joint is seldom as strong as it was formerly, although for all practical purposes the limb may be as useful as ever. Some degree of stiffness, of limited movement, or of muscular weakness, and occasional arthritic pains, and a liability to redislocation are the commonest sequelæ. Prolonged immobilisation is liable to lead to stiffness by permitting of the formation of adhesions, or of fibrous thickenings of tendons or ligaments; while too early movement tends to produce a laxity of the ligaments which favours redisplacement from slight causes.

*Treatment.*—Reduction should be attempted at the earliest possible moment. Every hour of delay increases the difficulty. The guiding principle is to cause the displaced bone to re-enter its socket by the same route as that by which it left it—that is, through the existing rent in the capsule. This is done by carrying out certain manipulations which depend upon the anatomical arrangement of the parts, and which vary, not only with different joints, but also with different varieties of dislocation of the same joint. In general terms it may be said that the main impediments to reduction are: the contraction of the muscles acting upon the displaced bone; the entanglement of the bone among tendons or ligamentous bands which fix it in its abnormal position; and the rent in the capsule being small or valvular, so that it forms an obstacle to the bone re-entering the socket.

Muscular contraction is best overcome by the administration of a general anæsthetic, and in all but the simplest cases this should be given to ensure accurate and painless reduction.

Failing this, however, the muscles may be wearied out by the surgeon making steady and prolonged traction on the limb, while an assistant makes counter-extension on the proximal segment of the joint. Advantage may also be taken of such muscular relaxation as occurs when the patient becomes faint, or when his attention is diverted from the injured part, to carry out the manipulations necessary to restore the bone to its normal position.

The appropriate manœuvres for disengaging the head of the bone from tendons, ligaments, or bony processes with which it may be entangled, will be suggested by a consideration of the anatomy of the particular joint involved, and will be described with individual dislocations.

It cannot be urged too strongly that any mechanical apparatus in the form of pulleys, levers, or fulcra is only to be used in exceptional cases and with the greatest care and caution. In reducing a dislocation no amount of physical force will compensate for a want of anatomical knowledge. All tugging, twisting, or wrenching movements are to be avoided, as they are liable to cause damage to blood-vessels, nerves, or other soft parts, or even—and especially in old people—to fracture one of the bones concerned.

In the *after treatment* much benefit is gained by the systematic use of *massage*; before any restraining apparatus is applied the whole region around the joint should be gently stroked in a centripetal direction for fifteen or twenty minutes; and this is to be repeated daily, each sitting lasting for from twenty minutes to half an hour. From the first day onward movement of the joint is carried out in every direction, except that which tends to bring the head of the bone against the injured part of the capsule; and the patient is encouraged to use the joint as early as possible. The appropriate apparatus and the period during which it should be worn will be considered with the individual dislocations.

*Operation in Simple Dislocations.*—In a limited number of cases, even with the aid of an anæsthetic, reduction by manipulation is found to be impossible. Resort must then be had to operation, which under aseptic conditions is a comparatively safe and satisfactory proceeding, although often difficult. It may happen that the undoing of the displacement is only possible after the removal of a portion of one or other of the bones.

**Compound Dislocations.**—Compound dislocations are usually the result of extreme violence produced by machinery or railway accidents, or by falls from great heights. In the majority of cases they are complicated by fracture of one or more of the constituent

bones of the joint, as well as by laceration of muscles, tendons, and blood-vessels. In the region of the ankle, wrist, and joints of the thumb, however, compound dislocation is sometimes met with uncomplicated by other lesions. The great risk is septic infection, which may result in serious impairment of the usefulness of the joint or even in its complete destruction, results towards which the concomitant injuries materially contribute. In many instances where septic infection has occurred, ankylosis is the best result that can be hoped for.

*Treatment.* — As a rule the first question that arises is whether amputation is necessary or not, and the considerations which determine this point are the same as in the case of compound fractures (p. 419).

When an attempt is to be made to save the limb the dislocation is reduced after the parts have been thoroughly purified. In many cases excision of portions of bone is necessary to ensure asepsis or to permit of reduction. Drainage-tubes are inserted, the rest of the wound closed, and a retentive apparatus applied, provision being made for the dressing of the wound.

**Dislocation complicated by Fracture.** — In certain dislocations the separation of small portions of bones or of epiphyses is of almost constant occurrence—for example, fracture of the coronoid process in dislocation of the elbow backwards, and chipping off of a portion of the edge of the acetabulum in dislocation of the hip. These neither add to the difficulties of diagnosis nor necessitate any modification of the treatment, and they need not be further referred to.

The commonest example of a fracture complicating a dislocation is fracture of the neck of the humerus coexisting with dislocation of the shoulder. Here the difficulty of diagnosis is greatly increased, and the treatment of both injuries requires to be modified. The dislocation must be reduced—by operation if necessary—before the fracture is treated, and in many cases it is advisable to secure the fragments of the broken bone by wires, pegs, or screws, to enable movement to be commenced early, and so to prevent stiffness of the joint.

**Old-standing Dislocations.**—When, from oversight or from unsuccessful treatment, a dislocation is left for some time unreduced, changes take place in and around the joint which render replacement by manipulation extremely difficult or impossible. The rent in the capsule closes upon the neck of the bone, and fibrous adhesions form between muscles, tendons, and other structures which have been torn. The articular cartilage of the

head, being no longer in contact with an opposing cartilage, tends to become converted into fibrous tissue, and may form adhesions with other fibrous structures in its vicinity. By pressing on adjacent structures it may form for itself a new socket of dense fibrous tissue which in time becomes lined with a secreting membrane. When the displaced head lies against a bone, the continuous pressure produces a new osseous socket, from the margins of which osteophytic outgrowths may spring, and the surrounding fibrous tissue becoming condensed, forms a strong capsule, and a new joint results. Meanwhile the cartilage of the original socket is converted into fibrous tissue, which may come to fill up the cavity. Changes resembling those of arthritis deformans may occur. The large blood-vessels and nerves in the vicinity may be pressed upon or stretched by the displaced bone, or may be implicated in fibrous adhesions. In course of time they become lengthened or shortened in accordance with the altered attitude of the limb.

In many cases the new joint is remarkably mobile and useful; but in others, pain, limited movement, and atrophy of muscles render it comparatively useless and call for surgical intervention.

*Treatment.*—It is always a difficult problem to determine the date after which it is inadvisable to attempt reduction by manipulation, and no rules can be laid down which will cover all cases. Rather must each case be decided on its own merits, due consideration being had to the risks which attend this line of treatment. The chief of these are: rupture of large blood-vessels or nerves which have formed adhesions with the displaced bone, or have become shortened in adaptation to the altered shape or length of the limb; tearing of muscles or tendons, or even of skin; fracture of the bone, especially in old people; and separation of epiphyses in the young.

Before carrying out the manipulations appropriate to the particular dislocation, all adhesions must first be broken down; and during the proceedings no undue force is to be employed. It is sometimes found that the displacement is prone to recur, even after reduction has been successfully accomplished.

When reduction by manipulation is inadvisable or has been unsuccessful, the question of operation arises. In this connection it is to be borne in mind that even with an open wound the replacement of the bone is often by no means easy, and it may be necessary to excise the head of the bone. Before deciding to operate, however, the surgeon must consider the amount of disability which the condition entails, and to what extent this is likely to be improved by the operation.

*Habitual* or *recurrent dislocation* is almost exclusively met with in the shoulder, and will be described with the injuries of that joint.

**Pathological Dislocations.**—Joints may become dislocated in the course of certain diseases. These pathological dislocations fall into three groups: (1) those due to gradual stretching of the capsular and other ligaments weakened by inflammatory and suppurative processes, such as sometimes follow on typhoid, scarlet fever or diphtheria, and in pyæmia; (2) those due to destructive changes in the ligaments and bones—typically seen in tuberculous arthritis, in arthritis deformans, and in Charcot's disease; (3) those associated with deformities.

These will be considered with the diseases which give rise to them.

**Congenital Dislocations.**—Congenital dislocations are believed to be the result of abnormal or arrested development *in utero*, and are to be distinguished from dislocations occurring during birth, which are essentially traumatic in origin. They will be described along with deformities.

# CHAPTER XXII.

## INJURIES IN THE REGION OF THE SHOULDER AND UPPER ARM.

Surgical Anatomy—Fractures of Clavicle: *Varieties*—Dislocations of Clavicle: *Varieties*—Dislocations of Shoulder: *Varieties*—Sprains and contusions of shoulder—Fractures of Scapula: Sites—Fractures of Upper End of Humerus: *Surgical neck; Separation of epiphysis; Fracture of head, anatomical neck, or tuberosities*—Fractures of Shaft of Humerus.

The injuries met with in the region of the shoulder include fractures and dislocations of the clavicle, fractures of the scapula, dislocations and sprains of the shoulder-joint, and fractures of the upper end of the humerus.

**Surgical Anatomy.**—For the examination of an injury in the region of the shoulder the patient should be seated on a low stool or chair. After inspecting the parts from the front, the surgeon stands behind the patient and systematically examines by palpation the shoulder girdle and upper end of the humerus. The uninjured side should be examined along with the other for purposes of comparison.

Immediately external to the supra-sternal notch, the sterno-clavicular articulation may be felt, the large end of the clavicle projecting beyond the margins of the small and shallow articular surface on the sternum. Any dislocation of this joint is at once recognised. The clavicle being subcutaneous throughout its whole length, any irregularity in its outline can be easily detected. A small tubercle (deltoid tubercle) which frequently exists near the acromial end is liable to be mistaken for a fracture. The outer end forms with the acromion the acromio-clavicular joint, which, however, is not always readily recognised. The fingers are now carried over the acromion, which often exhibits a prominent ridge in the situation of its epiphysial cartilage, which must not be mistaken for a fracture. The tip of the acromion is usually employed as a fixed point in measuring the length of the arm.

The outline of the spine of the scapula can be traced back to the vertebral border; and the body of the bone may be manipulated, and its movements tested by moving the arm.

The coracoid process can be recognised in the upper and outer angle

of the triangular depression bounded by the pectoralis major, the deltoid, and the clavicle.

The head and surgical neck of the humerus may now be felt from the axilla, if the axillary fascia is relaxed by bringing the arm to the side. The great tuberosity can be indistinctly felt on the outer aspect of the shoulder through the fibres of the deltoid. It lies vertically above the external condyle, and may be recognised to rotate with the shaft. The bicipital groove looks forward, and lies in a line drawn vertically through the biceps muscle.

The subclavian artery, with its vein to the inner side and the cords of the brachial plexus to the outer side, passes under the middle of the clavicle, and may be compressed against the first rib immediately above this bone.

## Fractures of the Clavicle.

Fracture of the clavicle is one of the commonest injuries met with in practice. As about one-third of the cases occur in

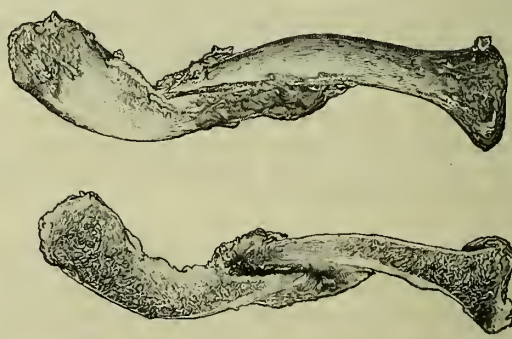


Fig. 105.—Recent Oblique Fracture of Left Clavicle in Middle Third. Upper figure shows superior aspect of bone. Lower figure shows sawn section.

children, the fracture is often of the greenstick variety. These fractures are seldom compound or complicated, unless as a result of gun-shot injuries; but occasionally the fragments pierce the skin, or press upon the subclavian vessels or the cords of the brachial plexus.

The most common situation is in the *middle third* (Fig. 105). This usually results from indirect violence, such as a fall on the outstretched hand, the elbow, or the outer aspect of the shoulder, the force being transmitted through the glenoid cavity to the scapula, and thence by the coraco-clavicular ligaments to the clavicle. The violence is, therefore, of a twisting character, and the bone gives way near the junction of the outer and

middle thirds, just where the two natural curves of the bone meet, and where the supporting muscular and ligamentous attachments are weakest.

The fracture so produced is usually oblique from above, downwards and inwards. The sternal fragment may be slightly drawn upwards by the sterno-cleido-mastoid, while the outer fragment falls by the weight of the arm, and the fragments usually overlap to the extent of about half an inch. The shoulder, having lost the buttressing support of the clavicle, falls in towards the chest wall, narrowing the axillary space, while the weight of the arm pulls it downward, and the muscles inserted in the region of the bicipital groove pull it forward.

Fracture of the middle third may result also from a direct stroke, such as the recoil of a gun, or from violent muscular contraction, the fracture as a rule being transverse, and the displacement less marked than in fracture by indirect violence.

*Clinical Features.*—The attitude of the patient is characteristic. The elbow is flexed, and is supported by the opposite hand, while the head is inclined towards the affected shoulder to relax the muscles of the neck. Crepitus is elicited on bracing back the shoulders, or on attempting to raise the arm beyond the horizontal, and these movements cause pain. Tenderness is elicited on making pressure over the seat of fracture, and also on distal pressure. The sternal fragment almost invariably overrides the acromial, and can usually be palpated through the skin; on measurement, the clavicle is found to be shortened. When the fracture is incomplete (green-stick) or transverse the symptoms are less marked.

*Simultaneous fracture of both clavicles* usually results from a severe transverse crush of the upper part of the thorax or from a fall on the outstretched hands. The middle third of the bone is implicated, and there is marked displacement and overriding. The patient is rendered helpless, and from the extrinsic muscles of respiration being thrown out of action, and the weight of the powerless limbs pressing on the chest, dyspnœa is a frequent accompaniment. These fractures are often complicated by injuries of the lung and pleura.

Fracture of the *outer third* of the clavicle is much less common, and usually results from direct violence, the bone being driven down against the coracoid process, and broken as one breaks a stick over the knee. The fracture may take place through the attachment of the conoid and trapezoid ligaments, in which case the only symptoms are pain and tenderness at the seat of fracture, with impaired movement of the limb.

Displacement and crepitus are prevented by the splinting action of the ligaments.

When the break is external to the attachment of the trapezoid ligament, the fracture is usually transverse, and is almost always due to a fall on the back of the shoulder—the angle between the spine and the acromion process striking the ground. The outer fragment rotates forward (Fig. 106), sometimes even to a



Fig. 106.—Fracture of Outer End of Clavicle. Shows forward rotation of outer fragment, and line of fracture united by osseous callus.

right angle, causing the tip of the shoulder to pass forwards, and so to lie slightly nearer the middle line. The integrity of the coraco-clavicular ligaments prevents any marked drooping of the shoulder. It is noteworthy that the displacement is not always evident at first.

Fractures of the *inner third* are very rare, are usually oblique (Fig. 107), and result either from an indirect force acting in the line of the clavicle, or, less frequently, from direct violence or

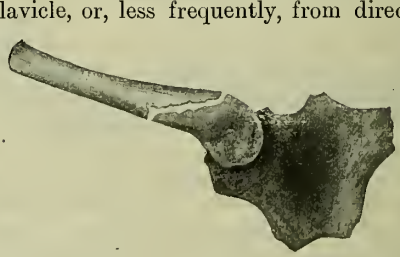


Fig. 107.—Recent Fracture of Inner End of Clavicle, seen from posterior aspect.

muscular action. As a rule the deformity is insignificant, except when the costo-clavicular ligament is torn, in which case the inner end of the outer fragment is tilted up by the weight of the arm. The shoulder passes downwards, forwards, and inwards. When close to the sternal end this fracture may simulate a dislocation of the sterno-clavicular joint or a *separation of the clavicular epiphysis.* This last is a very rare accident, which may occur between the seventeenth and the twenty-fifth years, and is usually the result of violent muscular

action. It differs from the other injuries in this region in being more easily reduced and retained in position, the epiphysis lying entirely within the limits of the capsular ligament of the sterno-clavicular joint.

The *prognosis* as to union in all these injuries is good. Firm bony union usually occurs within twenty-one days. Non-union, false joint, or fibrous union is but rarely met with. At the same time it is to be borne in mind that, in spite of all precautions, some deformity and shortening may result, without, however, interfering with the usefulness of the limb.

*Treatment.*—The displacement in complete fractures of the clavicle is readily reduced by supporting the elbow, bracing back the shoulders, and levering out the tip of the affected shoulder. In a few cases the interposition of some fibres of the subclavius muscle between the fragments has prevented perfect reduction.

In the greenstick variety the bone should be bent back into its normal position, even if the force required is sufficient to render the fracture a complete one. In spite of imperfect reduction, the clavicle usually straightens as it grows, and although some deformity may persist, the function of the limb is not interfered with.

*Treatment in the Recumbent Position.*—There is little doubt that the most perfect æsthetic results are obtained by treating the patient in the recumbent position. In the case of girls, therefore, in whom it is desired that the shoulders should be perfectly symmetrical, the best method of treatment is to place the patient on a firm mattress, with a narrow, firm cushion between the shoulder-blades, so that the weight of the shoulder may carry the acromial fragment outwards and backwards. A pad is inserted in the axilla, the elbow is raised, and the arm fixed by the side on a pillow with sandbags. Massage is applied daily to hasten the disappearance of the effused blood. As this position must be maintained uninterruptedly for two or three weeks, it proves too irksome for most patients. When both clavicles are fractured, however, it is, short of operation, the only available method of treatment, and the patient must be carefully nursed to prevent him moving the arms.

Satisfactory results are obtained by the method suggested by Wharton Hood. The fracture having been reduced, three strips of strong adhesive plaster, each an inch and a half wide, are applied from a point immediately above the nipple to a point two inches below the angle of the scapula. The middle strap should cover the seat of fracture, and should

be applied first; the lateral ones, slightly overlapping it, should extend about half an inch on either side. The forearm is supported in a sling. This appliance has the advantage that it permits of massage and movement of the shoulder being carried out from the first.

*Sayre's method*, which is specially adapted to fractures of the middle third, although applicable to all, consists in applying broad strips of adhesive plaster in such a way as to correct the threefold deformity. While it is excellent in principle, it is often found troublesome in practice, as the plaster is irritating and uncomfortable to the patient, and if it becomes slack or

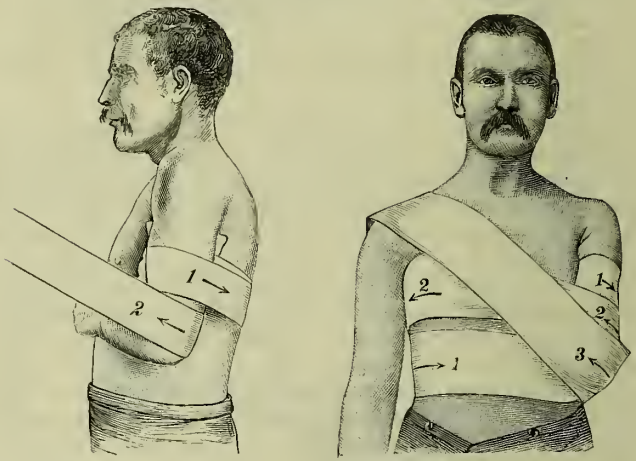



FIG. 108.—Duncan's Modification of Sayre's Method of treating Fracture of Clavicle. The *circular* body bandage has still to be applied.

fails to correct the deformity, must be completely removed and reapplied. These difficulties may be overcome by adopting *Duncan's modification*, which consists in employing a broad domette bandage in place of the adhesive plaster. A layer of wool is placed in the axilla to keep the skin surfaces apart, but it must not be used as a fulcrum to lever out the shoulder, as the pressure thus produced on the axillary vessels and nerves is liable to cause congestion, and numbness or pain in the limb beyond. A wide loop is then made on the end of the bandage, and passed round the middle of the upper arm (Fig. 108), care being taken that the limb is not constricted. The arm is pulled backward by carrying the bandage across the back, under

the opposite axilla, and round the thorax as far as the elbow. It is next looped round the back of the elbow, close above the condyles, and by being carried across the front of the chest to the opposite shoulder pulls the elbow forward and inwards, and so levers the shoulder backward and outward on the fulcrum formed by the loop round the upper arm. The next turn corrects the downward displacement by passing across the back, under the tip of the elbow—a slit being made in the bandage opposite the olecranon process—and along the forearm to the opposite shoulder. A circular body bandage is applied over all these turns, and safety-pins inserted at the crossings.

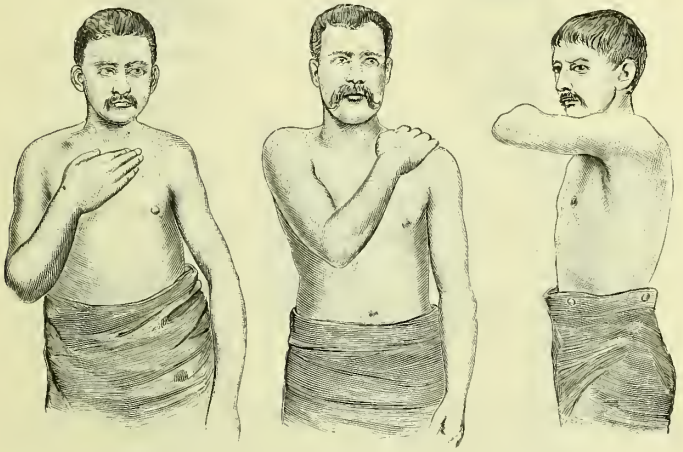



FIG. 109.—Attitudes of Limb according to Displacement in Chiene's Method.

*Chiene's Method.*—"In employing this method there are two points to be attended to—the position in which the arm is to be kept, and the method of applying the bandage. The more *downward* the displacement, the more *vertical* must the arm be kept (Fig. 109, A). If the displacement is *inwards*, the upper arm must be placed well *across the chest* (Fig. 109, B). If *forward* displacement is most marked, let the upper arm be placed as *horizontal* as possible (Fig. 109, C).

"Lay the tail of the bandage on the hand (Fig. 110 (1)); carry it down the back of the forearm, round the elbow, up the upper arm to the tip of the acromion (2), across the back to the opposite axilla, across the forearm (3), round the elbow

again, up the upper arm, then round below the deltoid (4), and across the back to the opposite shoulder (5), repeating these turns as often as is necessary. Last of all, fix the arm to the side by circular turns."—Chiene.

*The Handkerchief Method.*—In cases of emergency, one of the best methods applicable to all fractures of the clavicle is to brace back the shoulders by means of two padded handkerchiefs, folded *en cravate*, placed well over the tips of the shoulders and tied, or interlaced, between the scapulæ. The forearm is then supported by a third handkerchief applied as a sling, the base of

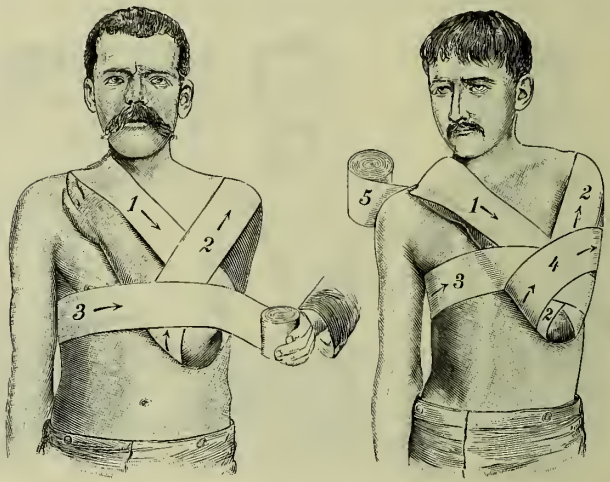



Fig. 110.—Chiene's Method of treating Fracture of Clavicle.

which is placed under the elbow, the ends passing over the sound shoulder.

*Operative treatment* may be called for in compound or comminuted fractures when the fragments have injured, or are likely to injure, the subclavian vessels or the cords of the brachial plexus, or when it is otherwise impossible to reduce the fracture or to retain the fragments in apposition. It is also indicated in some cases of simultaneous fracture of both clavicles. Silver wire or silk-worm gut is the most suitable material for suture. After the wound has healed, massage and movement are employed, as in simple fractures.

These various methods of treatment are not equally applicable to all cases. In our experience, in the circumstances indicated,

the following methods have proved the most satisfactory :—(1) As a temporary means of retention in emergency cases, for example, accidents occurring on the football field, the handkerchief method (p. 448). (2) In uncomplicated fractures of average severity in any part of the bone, the method of Wharton Hood (p. 445). (3) In cases where, for æsthetic reasons, the chief consideration is the avoidance of deformity and the maintenance of the symmetry of the shoulders, as in girls, the treatment by recumbency. (4) When retentive apparatus fails, or when the fragments are exerting injurious pressure, operative treatment.

### Dislocations of the Clavicle.

Dislocation of the **acromial end**—sometimes, and perhaps more correctly, spoken of as dislocation of the scapula—is

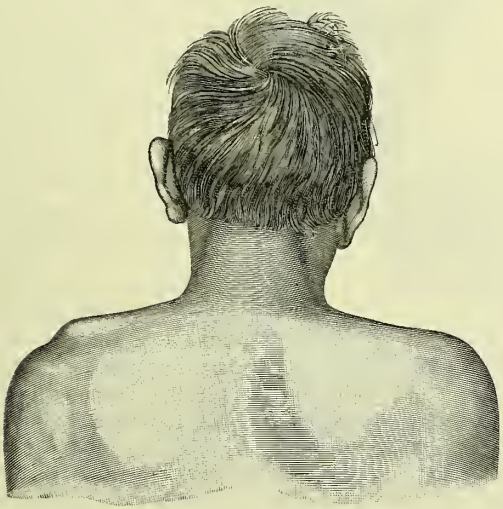


Fig. 111.—Dislocation of Acromial End of Left Clavicle upwards.

more frequent than that at the sternal end, and it usually results from a blow from behind, or from a fall on the tip of the shoulder, driving down the scapula, so that the clavicle projects *upwards* and overrides the acromion process (Fig. 111).

*Downward* displacement of the outer end of the clavicle is much rarer, and may follow a fall on the elbow or a blow over the clavicle. The end of the bone lies under the acromion

process, in contact with the capsule of the shoulder-joint, and the acromion stands out prominently.

**The sternal end** of the clavicle may be dislocated forwards, backwards, or upwards.

*Forward* dislocation is the most common, the end of the clavicle lies on the front of the sternum, somewhat below the level of the sterno-clavicular joint, and its articular surface can be distinctly palpated (Fig. 112). The interarticular cartilage sometimes remains attached to one bone, sometimes to the other, and the rhomboid ligament is usually intact.

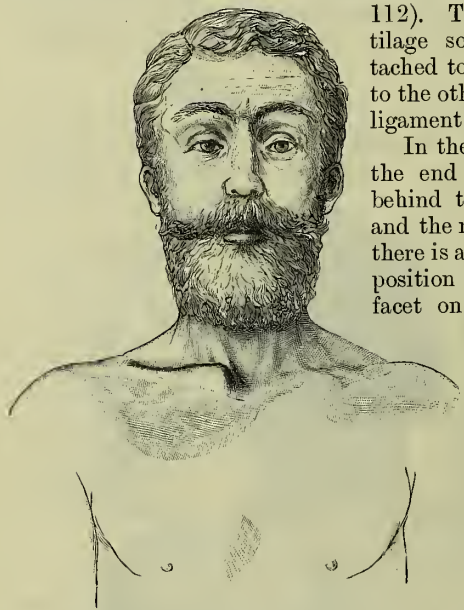


Fig. 112.—Forward Dislocation of Sternal End of Right Clavicle.

In the *backward* dislocation the end of the clavicle lies behind the manubrium sterni and the muscles attached to it; there is a marked hollow in the position of the joint, and the facet on the sternum can be felt. In a comparatively small number of cases the bone exerts pressure upon the trachea and œsophagus, producing difficulty in breathing and swallowing. It has also been known to press upon the subclavian artery and on other important structures at the root of the neck.

In rare cases the rhomboid ligament is torn, and the end of the clavicle passes *upwards*, and rests in the episternal notch behind the sterno-mastoid muscle.

Dislocation of *both ends* of the clavicle has occasionally occurred from a severe crush. The ultimate results have been satisfactory, as one or other end has always united in normal position, and the function of the arm has thus been maintained.

*Clinical Features.*—In *all varieties* the clinical features are so well marked that the diagnosis is unmistakable. The head inclines towards the affected side, and the tip of the shoulder

tends to pass slightly downward, forward, and inward. The displaced end of the bone can be seen and felt as a prominence under the skin (Figs. 111 and 112), or the empty socket can be palpated, while the muscles attached to the displaced clavicle stand out in relief. The nature of the lesion can usually be demonstrated by means of the X-rays. The movements at the shoulder are always restricted, particularly in the direction of abduction above the level of the shoulder. These injuries are sometimes associated with fracture of the ribs, a complication which adds materially to the difficulties of treatment.

*Treatment.* — Reduction is easily effected by bracing back the shoulders and replacing the bone in its socket by manipulation; but retention is invariably difficult, and in many cases impossible; even when the displacement is permanent, however, the usefulness of the arm is not necessarily impaired.

Dislocation of the *acromial end* is best treated by placing an elastic pad, such as a Turkey sponge, over the outer end of the clavicle, and fixing it in this position by a few turns of elastic bandage carried over the shoulder and under the elbow. The forearm is placed in a sling with the elbow well supported, and the arm is bound to the side by a circular bandage (Fig. 113). When redisplacement occurs and the usefulness of the limb is impaired, the joint surfaces may be rawed and the bones wired, with a view to obtaining ankylosis.



FIG. 113.—Treatment of Upward Dislocation of Acromial End of Clavicle.

The *sternal end* may be retained in position by keeping the shoulders braced back by a figure-of-eight bandage, or by padded handkerchiefs, and making pressure over the displaced end of the bone with a sponge-pad. The forearm is supported by a sling, and the arm fixed to the side. Imperfect reduction interferes so little with the functions of the limb that operative measures are seldom required except for æsthetic reasons.

It may be found useful to supplement these appliances by a shoulder-cap, especially in muscular or refractory subjects, and the patient should be confined to bed for a few days. Massage

should be employed from the first, and the patient should be allowed to move the arm by the end of a week.

## Dislocations of the Shoulder.

The shoulder is more frequently dislocated than all the other joints in the body taken together. This is explained by its exposed position, the wide range of movement of which it is capable, the length of the lever afforded by the humerus, and the anatomical construction of the joint—the large, round humeral head imperfectly fitting the small and shallow glenoid cavity, and the ligaments being comparatively lax and thin. The capsule of the joint is materially strengthened in its upper and back parts by the tendons of the supra- and infra-spinatus and teres minor muscles; while it is weakest below and in front, between the subscapularis and teres major tendons. It is here that it most frequently gives way and allows of displacement of the head of the bone.

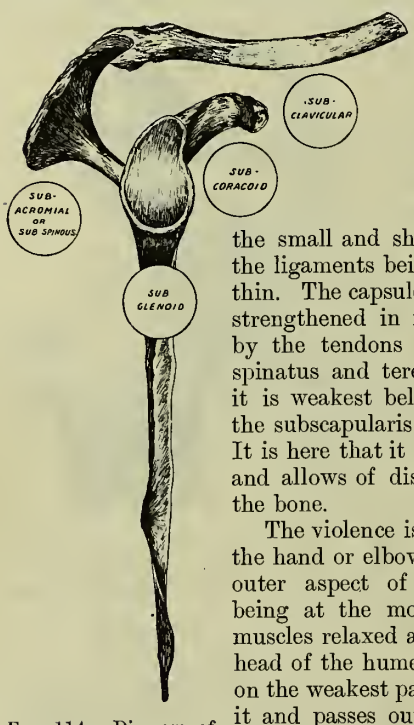



Fig. 114.—Diagram of most common varieties of Dislocation of the Shoulder.

The violence is usually transmitted from the hand or elbow, less frequently from the outer aspect of the shoulder, the limb being at the moment abducted and the muscles relaxed and taken unawares. The head of the humerus, thus brought to bear on the weakest part of the capsule, ruptures it and passes out through the rent. Dislocation is readily produced in an unconscious patient, and sometimes occurs in conducting artificial respiration or in handling a patient suffering from opium poisoning.

*Varieties.*—Several varieties of dislocation are recognised according to the position in which the head of the humerus finally rests (Fig. 114). The simplest and least complicated of these is the *sub-glenoid* variety, in which the head rests on the long head of the triceps where it arises from the

axillary border of the scapula just below the glenoid cavity. In almost all cases of dislocation of the shoulder the head of the bone is at least momentarily in this position, but the sharp edge of the scapula and the rounded head are ill adapted to one another, and the position is not long maintained. The subsequent course taken by the humerus depends upon the nature and direction of the force, the position of the limb at the moment of injury, and the relative strength and capacity for effective action of the different groups of muscles acting upon the bone.



Fig. 115.—Sub-coracoid Dislocation of Left Shoulder. Note flattening of shoulder, increase in depth of axillary fold, and attitude of patient.

In the great majority of cases it passes forward and inward, and comes to lie against the anterior surface of the neck of the scapula, under cover of the tendons of origin of the biceps and coracobrachialis muscles, constituting the *subcoracoid dislocation*. Much less frequently it passes still farther in and lies under cover of the pectoralis minor and against the edge of the clavicle—the *subclavicular* variety. In rare cases where the violence is extreme the head passes backward and lies against the spine on the dorsum of the scapula, beneath the infra-spinatus muscle—the *subspinous* variety. Other varieties are so rare that they do not call for special mention.

*Clinical Features common to all Varieties.*—Dislocations of the shoulder are commonest in adult males; in advanced life the proportion of female sufferers increases. They are usually attended with great pain, and there is often numbness of the limb due to pressure of the head of the bone upon the large nerve-trunks. There is sometimes considerable shock. The

patient inclines his head towards the injured side, and, while standing, the forearm is supported by the hand of the opposite side. The acromion process stands out prominently, the roundness of the shoulder giving place to a flattening or depression immediately below it, so that a straight-edge applied to the outer aspect of the limb touches both the acromion and the external condyle. The vertical circumference of the axilla is markedly increased. The head of the bone can be felt in its new position, and the axis of the humerus is correspondingly altered, the elbow being carried from the side — forward or backward according to the position of the head. The empty glenoid may sometimes be palpated from the axilla. In most cases, although not in all, the patient is unable at one and the same time to bring his elbow to the side and to place the hand upon the opposite shoulder (Dugas' symptom). Accurate measurements of the length of the limb from acromion to external condyle are not easily made, and are rarely of any diagnostic value.



Fig. 116.—Kocher's Method of reducing Sub-coracoid Dislocation—First Movement: External Rotation of Arm.

The **sub-coracoid dislocation** (Fig. 115) is that most frequently met with. It usually results from hyper-abduction of the arm while the scapula is fixed, as in a fall on the inner side of the elbow when the arm is abducted from the side. The surgical neck of the humerus is then brought to bear upon the under aspect of the acromion, which forms a fulcrum, and the head of the bone is pressed against the inner and lower part of the capsule. In some cases muscular action produces this dislocation, the mechanism being the same as when it is due to indirect violence. It may also result from force applied directly to the upper end of the humerus.

The head leaves the capsule through the rent made in its lower part, and, either from a continuation of the force or from contraction of the muscles inserted into the bicipital groove, particularly the great pectoral, passes inwards under cover of the biceps and coraco-brachialis till it comes to rest against the anterior surface of the neck of the scapula, just below the coracoid process. The anatomical neck of the humerus presses against the anterior edge of the glenoid, and there is frequently an indentation fracture of the head of the humerus where the two bones come into contact (F. M. Caird). The subscapularis is bruised or torn, the muscles inserted into the great tuberosity are greatly stretched, or the tuberosity itself may be avulsed, allowing the long tendon of the biceps to slip outwards, where it may form an impediment to reduction. The circumflex nerve is often bruised or torn, and the head of the humerus is liable to press injuriously on the axillary nerves and vessels.

The *clinical features* common to all dislocations are prominent, although Dugas' symptom is not constant.

*Treatment.*—The guiding principle in the reduction of these dislocations is to make the head of the bone retrace the course it took in leaving the socket. The main obstacles to reduction being muscular contraction and the entanglement of the head with tendons, ligaments, or bony points, appropriate means must be taken to counteract each of these factors.

A general anæsthetic is an invaluable aid to reduction, and should always be given unless there is some reason for withholding it. It is specially indicated in strong, muscular subjects, and in nervous patients who do not bear pain well, and particularly when the dislocation has existed for a day or two. In quite recent cases, however, the surgeon may sometimes succeed in replacing the bone by taking advantage of a temporary faintness, or by engaging the patient's attention with other matters while he carries out the appropriate manipulations.

When an anæsthetic is employed the patient should be laid on a mattress on the floor, or on a narrow, firm table; otherwise he should be seated on a chair.

*Kocher's method* is suitable for the great majority of cases of sub-coracoid dislocation. (1) The elbow is firmly pressed against the side, and the forearm flexed to a right angle. The surgeon grasps the wrist and elbow and firmly *rotates the arm outward* (Fig. 116) till distinct resistance is felt and the deltoid becomes more prominent. In this way the rent in the lower part of the capsule is made to gape, and the head of the humerus rolls outwards till it lies opposite the opening, rotation taking place

about the fixed point formed by the contact of the anatomical neck of the humerus with the anterior lip of the glenoid cavity (Waterston). (2) The *elbow is next carried forward, upward, and towards the middle line* (Fig. 117); the humerus acting as the long arm of a lever on the fulcrum furnished by the muscles inserted in the region of the surgical neck, the head, which forms the short arm of the lever, is carried backward, downward, and outward, and is thus directed towards the socket. (3) The arm is now *rotated inward* by carrying the hand across the chest



FIG. 117. — Kocher's Method — Second Movement: Elbow carried forward, upward, and towards the Middle Line.

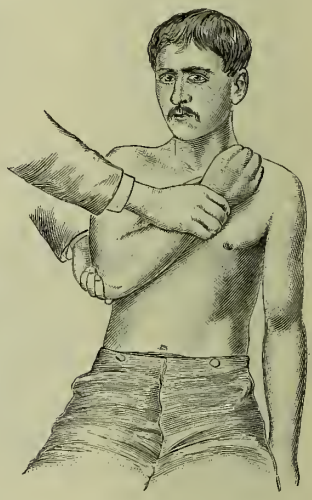


FIG. 118. — Kocher's Method — Third Movement: Inward Rotation of Arm.

towards the opposite shoulder (Fig. 118). The anatomical neck of the humerus is thus disengaged from the edge of the glenoid, and the head is pulled into the socket by the tension of the surrounding muscles.

A method of reduction has been formulated by A. G. Miller, which should be tried when Kocher's method fails. The limb is grasped above the wrist and elbow, the forearm flexed to a right angle, and the upper arm abducted to the horizontal. While an assistant makes counter-extension and fixes the scapula, the surgeon gradually draws the arm out from the body till the head of the humerus is felt to pass outwards.

The humerus is then rotated inwards by dropping the hand (Fig. 119), and the bone gradually glides into the socket.

In a certain number of cases reduction can be effected by *hyper-abduction* of the shoulder with traction. The patient is laid upon a firm mattress, and the scapula fixed by making pressure on the acromion, while the arm is slowly and steadily extended, and raised from the side till it is well above the head. In some cases the head of the humerus spontaneously slips into its socket; in others it may be manipulated into position by pressure from

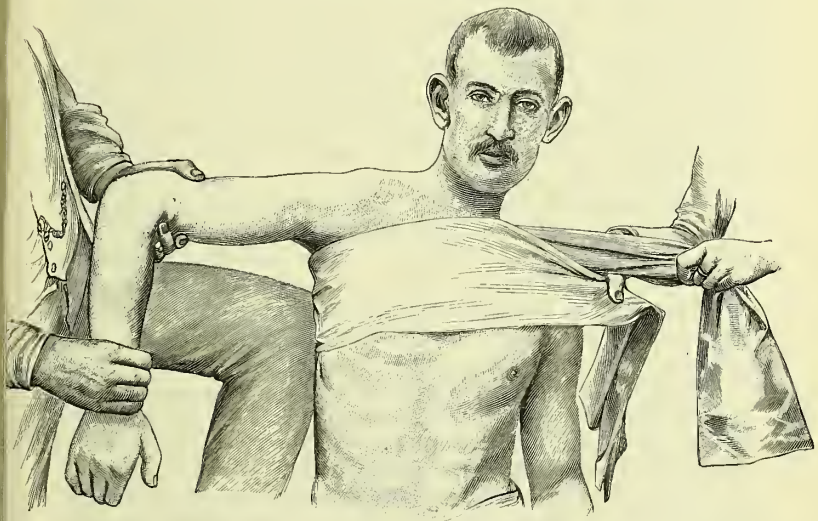


FIG. 119.—Miller's Method of reducing Sub-coracoid Dislocation—Second Movement.

the axilla. This method is restricted to recent cases, as in those of long standing the axillary vessels are liable to be stretched or torn.

The method of reduction by traction on the arm with the heel in the axilla has deservedly fallen into disrepute as being one which largely depends for its success on sheer force.

*After-Treatment.*—After reduction, the part is gently massaged for ten or fifteen minutes, a layer of wool is placed in the axilla, the forearm is supported by a sling, and the arm fixed to the side by a circular bandage. Massage is carried out daily from the first, and movement of the shoulder in every direction

except that of abduction may be commenced on the third or fourth day. Abduction movements may be commenced a week later, and the circular bandage may then be dispensed with. By the end of a month the patient should be advised to use the arm freely.

The **sub-clavicular dislocation** (Fig. 114) is to be looked upon as an exaggerated degree of the sub-coracoid rather than as a separate variety. It is produced by the same mechanism, but the violence is greater, and the damage to the soft parts more severe. The head passes farther in under cover of the pectoralis minor, resting under the clavicle against the serratus magnus and chest wall. The symptoms are usually so marked that they leave no doubt as to the diagnosis. The outline of the head of the humerus in its abnormal position is visible through the skin, and the shortening of the limb is more marked than in the sub-coracoid variety. The treatment is the same as for sub-coracoid dislocation.

**Sub-glenoid dislocation** (Fig. 114) is less frequently met with than the sub-coracoid variety, and almost always results from forcible abduction of the arm. The head of the humerus passes out through a small rent in the lower and inner portion of the capsule, and rests against the anterior edge of the triangular surface immediately below the glenoid cavity, supported behind by the long head of the triceps, and in front by the subscapularis muscle. It is readily felt in the axilla. All the tendons in relation to the upper end of the humerus are stretched or torn, and the great tuberosity is not infrequently avulsed. There is sometimes bruising of the circumflex nerve.

The projection of the acromion, the flattening of the deltoid, the increased depth of the axillary fold, and the abduction of the elbow are very marked; the arm is slightly lengthened, rotated out, and carried forward. It is reduced by the hyper-abduction method (p. 457).

**Sub-spinous Dislocation.**—Backward dislocation is usually termed sub-spinous, although in a considerable proportion of cases the head of the humerus does not pass beyond the root of the acromion process (*sub-acromial*) (Fig. 114). This dislocation is usually produced by a fall on the elbow, the arm being at the moment adducted and rotated in, so that the head of the humerus is pressed backwards and outwards against the capsule, which ruptures posteriorly. All the muscles attached to the upper end of the humerus are liable to be torn, and the tuberosities are frequently avulsed.

In the milder cases the *clinical features* are not always well

marked, and on account of the swelling from effusion this dislocation is apt to be overlooked. In addition to the ordinary symptoms, the shoulder is broadened, there is a marked hollow in front in which the coracoid projects, and the arm is held close to the side with the elbow directed forward. The head of the bone may be seen and felt in its abnormal position below the spine of the scapula.

Reduction can usually be effected by making traction on the arm with internal rotation, and pressing the head forward into position, while counter-pressure is made upon the acromion.

*Prognosis.*—The ultimate prognosis in dislocations of the shoulder should always be guarded. The circumflex nerve may be stretched or torn, and this may lead to atrophy of the deltoid, or other branches of the brachial plexus may be injured and the muscles they supply permanently weakened. In a certain number of cases traumatic neuritis has resulted in serious disability of the limb. The movements of the shoulder-joint may be restricted by cicatricial contraction of the torn portion of the capsule and of the damaged muscles. Recurrent dislocation may follow if the capsule becomes unduly lax or if the rent in it fails to close.

**Dislocation of the Shoulder complicated with Fracture of the Humerus.**—This double injury is fortunately very rare. The dislocation, which is almost invariably of the sub-coracoid variety, is produced by the usual mechanism of forced abduction, and the fracture of the surgical neck takes place by the violence continuing to act after the head has left the glenoid fossa. The head may be felt in its abnormal position, but does not move with the shaft when the humerus is rotated; crepitus, abnormal mobility at the seat of fracture, and shortening of the limb can usually be recognised. A general anæsthetic is almost always necessary to permit of an exact diagnosis being made, as well as to aid in reduction. The neck of the humerus has frequently been fractured during attempts to reduce an old-standing dislocation.

The first indication in *treatment* is to reduce the dislocation. In certain cases, when the head lies close to the glenoid cavity and the capsule is widely lacerated, this may be done by manipulating the upper fragment from the axilla. On no account should the lower fragment be employed as a lever in attempting reduction. When reduction by external manipulation fails, the upper fragment should be exposed by an incision over its outer aspect, and gripped by forceps or held by M'Burney's hook, which is specially constructed for the purpose

of serving as a lever with which to return the head to its socket.

Reduction having been accomplished, the fracture is adjusted in the usual way, advantage of the open wound being taken, if necessary, to fix the fragments together by wires or pegs. The best position in which to fix the limb is that of abduction at a right angle. Massage and movement should be commenced early to prevent stiffness of the joint.

When it is found impossible to reduce the dislocation, it is usually advisable to remove the upper fragment.

The method of allowing the fracture to unite without reducing the dislocation, and then attempting reduction, usually results in rebreaking the bone, or else in failure to replace the head in the socket, and has nothing to recommend it.

**Old-standing Dislocations of the Shoulder.**—It is impossible to lay down definite rules as to the date after which it is inadvisable to attempt reduction of an old-standing dislocation of the shoulder by manipulation. Experience of a hundred cases in Bruns' clinic led Finckh to conclude that, provided there are no complications, reduction can generally be effected within four weeks of the accident; that within nine weeks the prospect of succeeding is fairly good; but that beyond that time reduction is exceptional.

The patient is anæsthetised, and all adhesions broken down by free, yet gentle movement of the limb. The appropriate manipulations for the particular dislocation are then carried out, care being taken that no undue force is employed. If these are not successful they should be repeated after an interval of two or three days, as it is frequently found that reduction is successfully effected on a second or third attempt.

Should manipulative measures fail, it may be advisable to have recourse to operation if the age of the patient and his general health warrant it, and if the condition of the limb is interfering with his occupation, or involves serious disability. If operation is deemed advisable, a few days should be allowed to elapse to permit of the parts recovering from the effects of the manipulations. The joint is freely exposed, the capsule divided, the head of the bone freed and returned to the glenoid cavity. It is sometimes so difficult to replace the head of the bone that it is necessary to resect it and aim at the formation of a new joint, an operation which usually yields excellent results.

**Habitual or Recurrent Dislocation.**—Cases are occasionally met with in which the shoulder-joint shows a marked tendency

to be dislocated from causes altogether insufficient to produce displacement under ordinary circumstances. This condition is usually met with in young women, and, in some cases at least, appears to be due to too early and too free movement of the joint after an ordinary dislocation, so that the capsule is stretched and remains lax. The facility and frequency with which dislocation recurs render the limb comparatively useless, and may seriously incapacitate the patient.

The *treatment* consists in preventing the patient making the particular movements which tend to produce the dislocation. These are chiefly movements of hyper-abduction and overhead movements, such as are made, for example, in swimming or in arranging the hair. We have found an apparatus consisting of a belt applied round the thorax, and fixed to another round the upper arm by a band which passes above the axillary fold of the dress, useful in restraining these movements. If necessary, massage, electricity, and movements against resistance are employed to strengthen the weak muscles. If, after a prolonged trial, these measures fail, it may be advisable to tighten up the lax capsule by drawing it into folds by a series of catgut sutures, after which the joint is kept at rest for three or four weeks.

The condition is also met with in epileptics; and it is generally found that the head of the bone is deficient, as a result either of fracture or disease; that the muscles which naturally support the joint are atrophied or torn; and that the capsule is unduly lax.

**Sprains** of the shoulder-joint are comparatively rare because of the wide range of movement of which it is capable. The whole region becomes swollen and tender to pressure, the point of maximum tenderness being over the front of the joint, just below the acromion process; pain is elicited also when the ligaments or tendons are put upon the stretch.

**Contusions** of the region of the shoulder, on the other hand, are exceedingly common. In most cases it is merely the deltoid muscle and the subcutaneous tissue over it which are bruised, but sometimes a hæmatoma forms either in the muscle or in the sub-deltoid bursa. There is pain on moving the limb, and the patient may be unable to abduct the arm at the shoulder-joint. The symptoms usually pass off completely in two or three weeks, under treatment by massage and movement.

In other cases the circumflex nerve also is bruised, and these injuries are liable to be followed by prolonged pain, loss of abduction, and stiffness in the upper arm. The deltoid frequently undergoes considerable atrophy, and there is severe neuralgic pain

in the circumflex nerve, especially marked in the region of the insertion of the deltoid.

In addition to employing massage, and moving the limb, it is necessary to keep up the nutrition of the muscles by electricity. Benefit usually follows the use of hot-air baths. When these measures are not available, repeated blistering along the line of the circumflex nerve may be tried.

### Fractures of the Scapula.

Fractures of the scapula may implicate the body, the surgical neck, the acromion, or the coracoid process. They are rarely compound.

**Fracture of the Body.**—Considering its exposed position, the body of the scapula is comparatively seldom fractured, doubtless because of its mobility, and the support it receives from the elastic ribs and soft muscular cushion on which it lies. Apart from gun-shot injuries it is most frequently broken by a severe blow or crush. The scapula presents two natural arches—one longitudinal, the other transverse—and when the bone is crushed or struck the force produces fracture by undoing its curves (E. H. Bennett). A main fissure usually runs transversely across the infra-spinous fossa, and secondary cracks radiate from it. In other cases the line of the primary fracture is longitudinal, passing through the spine and involving both fossæ.

The *clinical features* are often obscured by swelling of the overlying soft parts. Crepitus may sometimes be elicited by placing one hand firmly over the bone, and with the other moving the arm and shoulder. When the spine is implicated the fragments may be grasped through the skin and made to move upon one another. The displacement, which usually consists in overlapping of the fragments—although sometimes they are drawn apart—is partly due to the action of the serratus magnus and teres major muscles, and partly depends on the direction of the force. Movement is restricted and painful. Osseous union usually takes place rapidly, and although displacement often persists, the function of the limb is unimpaired.

*Treatment.*—As these fractures are usually complicated by other injuries, especially of the thorax, and are accompanied by severe shock, it is necessary to confine the patient to bed. It is usually sufficient to fix the arm and shoulder to the chest wall by a firm binder or by strips of adhesive plaster, in the position which admits of the most complete apposition of fragments. This retentive apparatus is employed for about

three weeks, after which the patient is allowed to use his arm. After the first week the bandages are removed daily to admit of massage.

**Fracture of the surgical neck of the scapula**, although a rare accident, is of considerable clinical importance, as it is liable to be mistaken for dislocation of the shoulder. The line of fracture runs through the suprascapular notch, downwards and outwards to the lower margin of the glenoid, so that the glenoid and the coracoid process are separated from the rest of the bone. The coraco-acromial and coraco-clavicular ligaments are usually torn, and the detached fragment, along with the head of the humerus, sinks into the axilla, causing a flattening of the shoulder, and leaving a depression below the projecting acromion. The arm is lengthened by about an inch. By supporting the arm the deformity is at once reduced, but recurs as soon as the support is withdrawn. Crepitus is usually detected on carrying out this manipulation; and the coracoid process is found to move with the arm and not with the scapula. By these tests this injury is distinguished from a dislocation.

A partial fracture carrying away the lower part of the glenoid cavity sometimes simulates a sub-glenoid dislocation. This is, however, a very rare injury.

The *treatment* consists in bracing back the shoulders and supporting the elbow, and this is most satisfactorily done by means of Duncan's or Chiene's bandage in the same way as for fracture of the middle third of the clavicle (p. 446). Passive movement and massage are employed from the first, and the bandage should be kept on for about four weeks.

**Fracture of the acromion process** may result from a blow or fall on the shoulder. It is often overlooked clinically on account of the swelling resulting from bruising of soft parts, and the absence of marked displacement. On palpation, crepitus and an irregularity at the seat of fracture may sometimes be detected. The shoulder is slightly flattened, and abduction of the arm is difficult. In rare cases the fracture passes into the acromio-clavicular joint, and is associated with dislocation of the clavicle.

In connection with this fracture, reference must be made to a condition frequently met with, in which the epiphysial portion of the acromion is found to be separate from the body of the process. This is by some (Symington, Hamilton) looked upon as a want of union of the epiphysis, but the weight of evidence seems to prove that it is rather of the nature of an un-united fracture at this level, even when, as sometimes happens, it is bilateral (Struthers, Lane).

Between the fourteenth and twenty-second years the *epiphysis* may be separated, but it is seldom possible to make a positive diagnosis of this injury. As is the case in all fractures of the acromion, bony union seldom takes place.

The *treatment* is the same as for fracture of the outer end of the clavicle.

**Fracture of the coracoid process** is exceedingly rare. It may result from direct violence, such as the recoil of a gun, but is more often an accompaniment of dislocation of the shoulder or of the outer end of the clavicle upward. As the coraco-clavicular ligaments usually remain intact, there is no displacement; but when these are torn the coracoid is dragged downwards and outwards by the combined action of the pectoralis minor, biceps, and coraco-brachialis muscles. Crepitus may be elicited on moving the fragment. *Separation of the epiphysial portion* of the coracoid may occur up to the seventeenth year of life.

The *treatment* consists in placing the arm across the front of the chest, to relax the muscles causing the displacement, and retaining it in that position by a sling and roller bandage.

### Fractures of the Upper End of the Humerus.

It is most convenient to study fractures of the upper end of the humerus in the following order: (1) fracture of the surgical neck; (2) separation of the epiphysis; (3) fracture of head, anatomical neck, or tuberosities.

**Fracture of the Surgical Neck.**—The surgical neck of the humerus extends from the level of the epiphysial junction to the insertion of the pectoralis major and teres major muscles, and it is within these limits that most fractures of the upper end of the bone occur. They are most common in adults, and usually follow direct violence applied to the shoulder, but may result from falls on the hand or elbow, or from violent muscular action, as, for example, in throwing a stone. The fracture is usually transverse, and there is often little or no displacement, the fragments being retained in position by the long tendon of the biceps and the long head of the triceps. When the fracture is oblique, the fragments are often comminuted, and sometimes impacted. The displacement of the upper fragment seems to depend upon the attitude of the limb at the moment of fracture. When the upper arm is approximated to the side, the upper fragment retains its vertical position, but is slightly rotated outwards by the muscles inserted into the greater tuberosity, while the lower fragment is drawn upwards

and inwards towards the coracoid process by the muscles inserted into the bicipital groove and the longitudinal muscles of the upper arm, and may be felt in the axilla. The elbow points outwards and backwards, and the upper arm is shortened. The shoulder retains its rotundity, but there is a slight hollow some distance below the acromion. On moving the shaft it is found that the head and tuberosities do not move with it, and unnatural mobility and crepitus at the seat of fracture may be detected. When the upper arm is abducted at the moment of fracture, the upper fragment is retained in that position by the external rotator and abductor muscles inserted into it, while the lower fragment passes upwards and inwards as before.

Although there is sometimes overlapping and broadening after union, the usefulness of the limb is seldom impaired.

*Treatment.*—To ensure accurate reduction a general anæsthetic is usually necessary. If the fracture is *transverse* there is little or no displacement, and as the line of fracture is high up in the axilla and deeply placed among muscles, it is not possible to control the fragments by local splints applied so as to surround the fracture. A soft, elastic pad of cotton wool is placed in the hollow of the axilla, and fixed in position by a triangular handkerchief or figure-of-eight bandage. The shoulder-joint is controlled by a poroplastic shoulder-cap (Fig. 120), the elbow by a rectangular splint, and the forearm is supported by a sling.

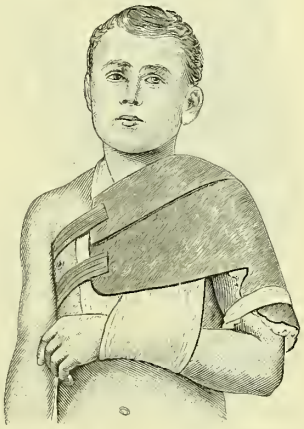


Fig. 120.—Sling and Poroplastic Shoulder-Cap applied for Fracture of Surgical Neck of Humerus. The rectangular splint is not figured.

Another method, described by Professor Chiene, is as follows: "Lay the arm across the chest, and the hand over the opposite shoulder. The tail of a bandage is then placed on the shoulder of the injured arm and carried down the upper arm, round beneath the elbow and up along the back of the forearm to the opposite shoulder, then across the back to below the deltoid of the injured arm, round the upper arm to the elbow, repeating as often as necessary. Last of all, fix the arm to the chest by circular turns" (Fig. 121).

When the fracture is *oblique* there is considerable tendency for the lower fragment to be redisplaced upward. In such cases care must be taken to avoid supporting the elbow by splint or sling, and it may even be necessary to apply extension to counteract this tendency (Fig. 122).

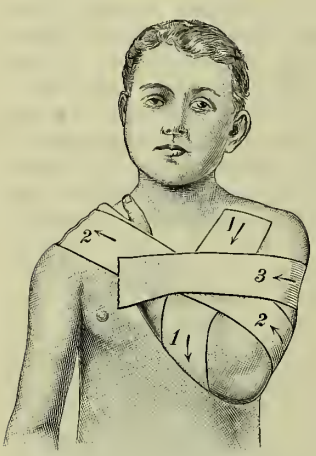



Fig. 121.—Chiene's Bandage for Fracture of Surgical Neck of Humerus. The turns fixing the arm to the chest are not figured.

In cases where the upper fragment remains abducted, or in which the fracture is oblique or comminuted and redisplacement occurs, the patient may be treated in bed, and extension with weight and pulley carried over the side of the bed; or Middeldorpf's triangular splint may be used. This consists of a double-inclined plane, the base of which is fixed to the patient's side, while the injured arm rests on the other two sides of the triangle (Fig. 123).



Fig. 122.—Weight Extension applied for Oblique Fracture of Surgical Neck of Humerus.

Should these measures fail, the fracture may be exposed by an incision carried along the anterior border of the deltoid, and the ends pegged, wired, or otherwise mechanically fixed, after which the limb is put up in one of the ways already described. The apparatus should be worn for three or four weeks, massage being commenced on the second or third day. Union is usually complete in about four weeks.

**Separation of Epiphysis.** — The upper epiphysis of the humerus includes the head, both tuberosities, and the upper fourth of the bicipital groove (Fig. 124). On its under aspect is a cup-like depression into which the central pyramidal-shaped portion of the diaphysis fits. This epiphysis unites about the twenty-first year.

Traumatic separation is met with chiefly between the fifth and fifteenth years, and is most common in boys. It usually results from forcible traction of the arm upwards and outwards, as in lifting a child by the upper arm, or from direct violence, but may be caused by a fall on the outer side of the elbow.

The epiphysis, especially in young children, may be separated without being displaced, or the displacement may be incomplete. When the epiphysis is completely separated from the shaft, the clinical features closely resemble those of fracture of the surgical neck, and the diagnosis is made by a consideration of the age of the patient, and the muffled character of the crepitus, when it can be elicited. The upper end of the diaphysis forms a projecting edge which may be felt nearer the coracoid process than in fracture of the surgical neck. The diagnosis can usually be established by the use of the X-rays. Dislocation is rare at the age when separation of the epiphysis occurs.

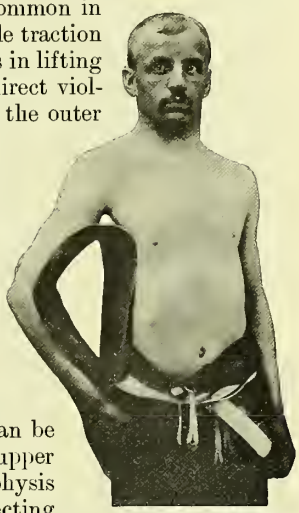


Fig. 123.—Wedge-shaped Splint of Poroplastic for treatment of Fractures at Upper End of Humerus in abducted position. To avoid obscuring the splint the bandages have been omitted.



Fig. 124.—Upper Epiphysis of Humerus.

(After Poland.)

Reduction is often difficult on account of the periosteum and other soft tissues getting between the fragments, and on account of the small size of the upper fragment. Union almost invariably results, but the growth of the limb may be seriously interfered with (Fig. 125), and its shape is sometimes much altered, especially when the injury occurs at an early age and its nature is overlooked.

*Treatment.*—This injury is treated on the same general lines as fracture of the surgical neck, but the details are more difficult to carry out, on account of the shortness of the upper fragment, the extensive laceration of soft parts, and the restlessness and

intractability of the patient. General anæsthesia is almost always necessary to secure satisfactory reduction, and retention is often only possible if the patient is confined to bed with the upper arm fixed in the abducted position. Operative treatment is more frequently called for than in fracture of the surgical neck. In some cases it is possible to replace the fragments and fix them in position by pegs or wire; more frequently resection of the upper end of the diaphysis is necessary before they can be approximated; and in some cases it has even been found necessary to remove the epiphysis.

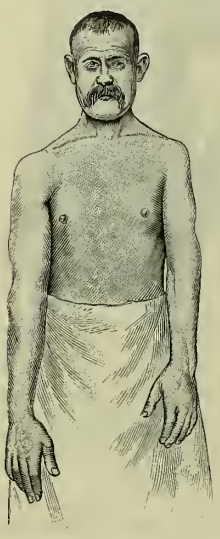


FIG. 125.—Shortening of Upper Arm from Injury to Upper Epiphysis in Childhood.

**Fractures of the Head, Anatomical Neck, and Tuberosities of Humerus.**—These fractures are met with as accompaniments of dislocation of the shoulder, and as results of gun-shot injuries, blows, or falls.

In sub-coracoid dislocation the *head* of the humerus is often indented by coming in contact with the anterior edge of the glenoid cavity.

The *anatomical neck* may be fractured by a direct blow on the shoulder in an old person. In a few cases the fracture is entirely intra-capsular, the head of the bone remaining loose in the cavity of the joint. As a rule, however, the fracture passes through the anatomical neck only on the inner side, diverging into the tuberosities externally. In some cases there is impaction, and in others comminution of the fragments. The use of the X-rays has shown that in many cases in which prolonged stiffness has followed a severe blow over the shoulder there has been a fracture of the anatomical neck.

The *tuberosities* may be implicated in other fractures in this region; and either of them may be separated by muscular contraction or by direct violence.

*Clinically* all these injuries are difficult to diagnose with accuracy, and, without the use of the X-rays, it is impossible in many cases to go further than to say that a fracture exists above the level of the surgical neck. Fracture of the anatomical neck is attended with little deformity beyond slight flattening

of the shoulder and sometimes slight shortening of the upper arm.

When the great tuberosity is torn off, considerable antero-posterior broadening of the shoulder may be recognised by grasping the region of the tuberosities between the fingers and thumb. Crepitus can be elicited on rotating the humerus. At the same time it will be recognised that the tuberosity does not move with the shaft. Firm union, with considerable formation of callus and some broadening of the shoulder, usually results, but the usefulness of the joint is not necessarily impaired. There may, however, be prolonged stiffness and impaired movement from adhesions; or pain and crackling in the joint may result from arthritic changes of the nature of arthritis deformans.

*Treatment.*—These fractures are treated on the same lines as fracture of the surgical neck of the humerus. Massage and movement should be commenced within a few days of the injury, to avoid stiffness of the shoulder. Operative treatment is seldom called for.

### Fracture of the Shaft of the Humerus.

Fractures occurring in the shaft of the humerus, between the surgical neck and the base of the condyles, may, for convenience of description, be divided into those above, and those below, the level of the deltoid insertion—the majority being in the latter situation.

Direct violence is the most common cause of these fractures, but they may occur from a fall on the elbow or hand; and a considerable number of cases are on record where the bone has been broken by muscular action—as in throwing a cricket-ball. Twisting forms of violence may produce spiral fractures (Fig. 95).

The fracture is usually transverse in children and in cases where it is due to muscular action. In adults, when due to external violence, on the other hand, it is usually oblique, the fragments overriding one another and causing shortening of the limb. The displacement depends largely on the direction of the force and the line of fracture, but to a certain extent also on the action of muscles attached to the fragments. Thus, in fractures above the insertion of the deltoid the upper fragment is usually dragged inward by the muscles inserted into the bicipital groove, while the lower is tilted out by the deltoid. When the break is below the deltoid insertion the displacement

of the fragments is reversed. Undue mobility, deformity, crepitus, and the other signs of fracture are evident, and the patient himself usually recognises that the bone is broken. The nerve-trunks in the upper arm, particularly the median, ulnar, and musculo-spiral, are apt to be damaged in these injuries. In fractures of the lower part of the shaft the musculo-spiral nerve is specially liable to be implicated. This may occur at the time of the injury, the nerve being contused y the force causing the fracture, or pressed upon by one or other of the fragments, or its fibres may be partially or completely torn across. Later it may become involved in callus, or be damaged by the pressure of ill-fitting splints. Weakness or paralysis of the extensors of the wrist and hand results, giving rise to the characteristic "wrist-drop." The actions of the muscles should always be tested before applying splints, and each time the apparatus is removed or readjusted, to ensure that no undue pressure is being exerted on the nerves. In this way the practitioner will recognise the nerve lesion as soon as it occurs, and will guard himself against actions for malpraxis should paralysis of the muscles ensue.

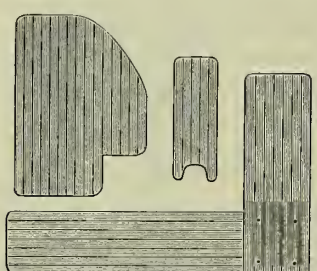


FIG. 126.—Gooch Splints for Fracture of Shaft of Humerus; and rectangular splint to secure elbow.

Union takes place in from four to six weeks in adults, and in from three to four weeks in children. Delayed union, or want of union and the formation of a false joint, is more common in fractures of the middle of the shaft of the humerus than in any other long bone. This is largely due to the frequency with which soft structures come to lie between the fragments. Arrest of growth in the bone from injury to the nutrient artery is also said to have occurred.

*Treatment.*—In treating a fracture of the shaft of the humerus the possibility of non-union should always be kept in mind. Reduction is effected, by the aid of a general anæsthetic if necessary, care being taken that no soft tissue intervenes between the fragments. The appearances seen with the X-rays may yield information on this point, a clear space persisting between the fragments even when they are pushed together. The local splint to control the fracture is applied in the form of a ferrule surrounding the bone. This may consist of several short, narrow pieces of wood secured by a bandage or strap and

buckle ; or better, of two pieces of Gooch splinting cut as in Fig. 126, special provision being made for avoiding pressure on the condyles. The elbow is fixed at a right angle and secured by a rectangular splint, the forearm being midway between pronation and supination, and the forearm is supported in a sling. For a few days the shoulder may be controlled by a shoulder-cap, or by binding the limb to the chest by a wide roller bandage.

From the second week onward the splints are removed daily to admit of massage and movement being carried out, and while the splints are off the patient is allowed to exercise the fingers and wrist. If, at the end of four or five weeks, osseous union has not occurred, the reparative process may be hastened by inducing venous congestion by Bier's method.

In oblique fractures, when there is difficulty in preventing overriding and redisplacement, the fragments may be exposed by incision, and fixed together by mechanical means.

When there is evidence that the musculo-spiral nerve has been injured, and no sign of improvement appears within three or four days of the accident, operative interference is indicated. An incision is made on the outer side of the arm, and the nerve exposed and freed from pressure, or stitched as may be necessary. In cases of old standing it has been found necessary to resect a portion of the shaft of the humerus to enable the ends of the nerve to be approximated. The opportunity should also be taken of dealing with the fracture as may be necessary.

In cases of *un-united fracture* a vertical or semilunar incision is made over the outer aspect of the bone, and the muscles separated from one another till the fracture is exposed, care being taken to avoid injuring the musculo-spiral nerve. The fibrous tissue is removed from the ends of the bone and the rawed surfaces fixed in apposition by pegs, screws, or wires. The wound is then closed, and appropriate splints and other retentive apparatus applied. As soon as the wound has healed massage is commenced.

# CHAPTER XXIII.

## INJURIES IN THE REGION OF THE ELBOW AND FOREARM.

Surgical Anatomy — Examination of injured elbow — Fractures of Lower End of Humerus: *Supra-condylar; Inter-condylar; Separation of epiphysis; Fracture of either condyle alone; Fracture of either epicondyle alone*—Fractures of Upper End of Ulna: *Olecranon; Coronoid*—Fractures of Upper End of Radius: *Head; Neck; Separation of epiphysis*—Dislocations of Elbow: *Both bones; Ulna alone; Radius alone*—Fractures of Forearm: *Both bones; Radius alone; Ulna alone.*

The injuries met with in the region of the elbow-joint include the various fractures of the lower end of the humerus, and upper ends of the bones of the forearm, including the olecranon process; and dislocations and sprains of the elbow-joint. The differential diagnosis is often exceedingly difficult, on account of the great swelling and tension which rapidly supervene on most of these injuries, the pain caused by manipulating the parts, and the difficulty of determining whether movement is taking place *at* the joint or *near* it.

**Surgical Anatomy.**—The internal epicondyle of the humerus is more readily felt through the skin than the external. The two epicondyles are practically on the same level, and a line joining them behind passes just above the tip of the olecranon process when the arm is fully extended. On flexing the joint, the tip of the olecranon gradually passes to the distal side of this line, and when the joint is fully flexed the tip of the olecranon is found to have passed through half a circle. The head of the radius can be felt to rotate in the dimple on the back of the elbow just below the external condyle. The coronoid process may be detected on making deep pressure in the hollow in front of the joint. The upper arm forms with the fully extended and supinated forearm an obtuse angle, opening outward—the "carrying angle." This angle is usually more marked in women, in harmony with the greater width of the female pelvis. The ulnar nerve lies in the hollow between the olecranon and the internal condyle, and the median nerve passes over

the front of the joint, with the brachial artery and biceps tendon to its outer side. The musculo-spiral nerve divides into its radial and posterior interosseous branches at the level of the outer condyle.

In *examining an injured elbow*, the thumb and middle finger are placed respectively on the two epicondyles, while the index locates the olecranon and traces its movements on flexion and extension of the joint. The movements of the head of the radius are best detected by pressing the thumb of one hand into the depression below the external condyle, while movements of pronation and supination are carried out by the other hand. The uninjured limb should always be examined for purposes of comparison.

In all forms of injury about the elbow much aid in diagnosis is obtained by the use of the X-rays. In cases of suspected fracture, a radiogram should be taken with the back of the limb resting on the sensitive plate, the forearm being extended and supinated. If a dislocation is suspected and a lateral view is desired, the arm should be placed on its inner side. It is useful to take radiograms of the healthy limb in the same position.

## Fractures of the Lower End of the Humerus.

The following fractures occur at the lower end of the humerus: (1) supra-condylar fracture; (2) inter-condylar fracture; (3) separation of epiphyses; (4) fracture of either condyle alone; and (5) fracture of either epicondyle alone.

All these injuries are common in children, and may result from a direct fall or blow upon the elbow, or from a fall on the outstretched hand, especially when at the same time the joints are forcibly moved beyond their physiological limits, more particularly in the direction of pronation or abduction. While it is generally easy to diagnose the existence of a fracture, it is often exceedingly difficult to determine its exact nature. Although the ulnar and median nerves are liable to be injured in almost any of these fractures, they suffer much less frequently than might be expected.

Ankylosis, or, more frequently, locking of the joint, is a common sequel to many of these injuries. This is explained by the difficulty of effecting complete reduction, and by the wide separation of periosteum which often occurs, favouring the production of an excessive amount of callus, particularly in young subjects.

The **supra-condylar** fracture usually results from a fall on the outstretched hand with the forearm partly flexed, from a direct blow, or from a twisting form of violence. The line of fracture is generally transverse, or but slightly oblique from behind downwards and forwards, so that the lower fragment is forced backward together with the bones of the forearm, simulating

backward dislocation of the elbow. The lower end of the upper fragment lies in front of the elbow.

*Clinical Features.*—The elbow is flexed at an angle of 120° or 130°, and the forearm, held semi-pronated, is supported by the other hand. Around the seat of fracture great swelling rapidly ensues. The olecranon projects behind, but the mutual relations of the bony points of the elbow are unaltered. The lower end of the upper fragment may be felt in front above the level of the joint, as a rough and sharp projection, and this sometimes pierces the soft parts and renders the fracture compound. The joint movements are normal, but unnatural mobility may be detected above the level of the joint. Crepitus and localised tenderness may be elicited. The displacement is readily reduced by manipulation, but is usually reproduced when the support is withdrawn. The upper arm is shortened to the extent of about half an inch.

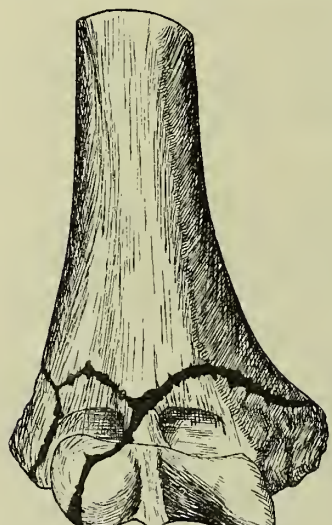


Fig. 127. — Inter-condylar Fracture of Lower End of Humerus, from a crush between buffers, in a man æt. 19.

In rare cases the obliquity of the fracture is downward and backward, and the lower fragment is displaced forward.

The **inter-condylar** fracture is a combination of the supra-condylar with a vertical split running through the articular surface, and so implicating the joint (Fig. 127). The condyles are thus separated from one another, as well as from the shaft, by a T- or Y-shaped cleft. As such fractures usually result from severe forms of direct violence, they are often comminuted and compound. In addition to the signs of supra-condylar fracture, the cavity of the joint is filled with blood. The condyles may be felt to move upon one another, and coarse crepitus, which has been likened to the feeling of a bag of beans, may be elicited if the fragments are comminuted.

**Separation of the lower epiphysis** (Figs. 128 and 129) of the humerus is a comparatively frequent injury in children of

three or four years of age. It may occur up to the thirteenth or fourteenth year, but beyond that age the lesion is usually a combination of separated epiphysis with fracture. This lesion is produced by the same forms of violence as cause supracondylar fracture. If the periosteum is not torn there is little or no displacement, but as a rule the clinical features closely resemble those of transverse fracture above the condyles, or of dislocation of the elbow. In separation of the epiphysis there is a peculiar deformity of the posterior aspect of the joint, consisting of two projections—one the olecranon process, and the other the prominent capitellum with a scale of cartilage which it carries with it from the external condyle (R. W. Smith and E. H. Bennett). The end of the diaphysis may be palpated through the skin in front. Muffled crepitus can usually be elicited, and there is pain on pressing the segments against one another. Sometimes the separation is *compound*, the diaphysis protruding through the skin.

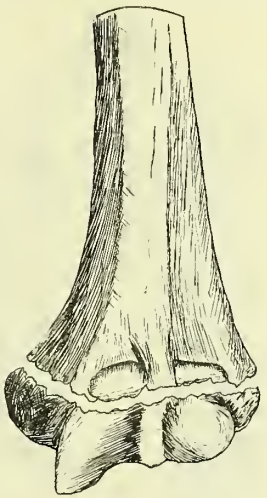


Fig. 128.—Complete Separation of Lower Epiphysis of Humerus.

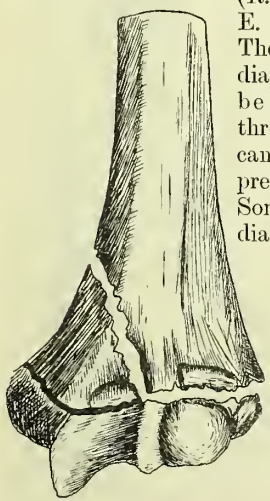


Fig. 129.—Partial Separation of Lower End of Humerus with fracture of Diaphysis.

Union takes place more rapidly than in true fracture, but owing to the excessive formation of callus from the torn periosteum in front of the joint, full flexion is often interfered with. If the displaced epiphysis is imperfectly reduced, serious interference with the function of the elbow is liable to ensue, and may call for operative interference.

**Fracture of either Condyle alone.**—The *internal* condyle or trochlea is more frequently separated from the rest of the bone than is the external or capitellum. In either, the size of the fragment varies, but the line of fracture is always partly extra-capsular and partly

intra-capsular, so that the joint is always involved. Pain, crepitus, and the other signs of fracture are present. As the ligaments of the joint are not as a rule torn, there is little or no immediate displacement of the fragment. Secondary displacement is liable to occur, however, during the process of union, producing alterations in the "carrying angle" of the limb — *cubitus varus* or *cubitus valgus* (Figs. 130 and 131).

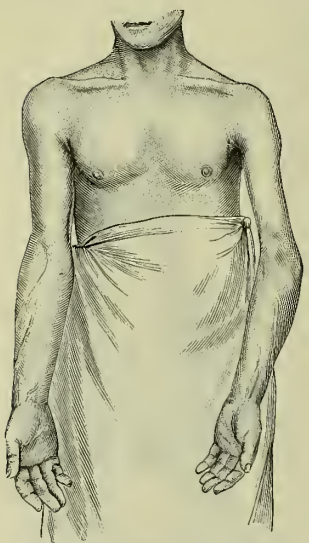


FIG. 130.—Cubitus Varus of Left Arm resultiug from Fracture of Internal Condyle of Humerus in childhood. Note imperfect development of upper arm.

**Fracture of Epicondyles.** — Fracture of the *external epicondyle* alone is so rare that it need only be mentioned.

The *internal epicondyle* may be chipped off by a fall on the edge of a table or kerb-stone, or it may be forcibly avulsed by traction through the internal lateral ligament, as an accompaniment of dislocation. It is usually displaced downwards and forwards by the flexor muscles attached to it, and may thus come to exert pressure on the ulnar nerve. The fragment may be grasped and made to move on the shaft, producing crepitus. Fibrous union is the usual result.

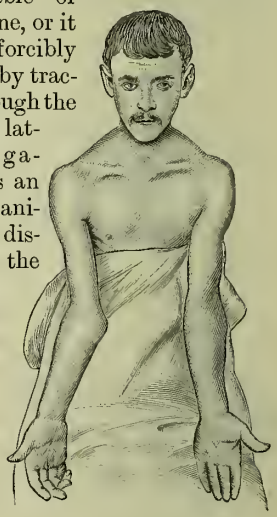


FIG. 131.—Cubitus Valgus of Right Arm resulting from Fracture of External Condyle in childhood. Note imperfect development of upper arm.

Up to the age of seventeen or eighteen the epiphysis of the epicondyle may be separated.

**Treatment of Fractures in region of Elbow.**—The administration of a general anæsthetic is a valuable aid to accurate reduction and fixation of fractures in this region. Much discussion has taken place as to the best position in which

to treat these fractures, and the consensus of opinion seems now to be in favour of full flexion at the elbow. In this view clinical experience is supported by the evidence afforded by the Röntgen rays. In no other position can the fragments be brought into such accurate apposition.

The *supra-condylar fracture* is reduced by first extending the elbow to free the lower fragment from the triceps, and then, while making traction through the forearm, manipulating the fragments into position, and finally flexing the elbow to an acute angle. In this way the triceps is put upon the stretch and forms a natural posterior splint. A pad is placed in the bend of the elbow to separate the opposed skin surfaces, and the elbow fixed in this position by means of a figure-of-eight bandage. If necessary this may be supplemented by a posterior, gutter-shaped splint of poroplastic, or by a modification of Croft's splint placed along each side of the limb. The arm is placed in a sling so arranged as to support the elbow. Movement and massage should be begun in two or three days, care being taken that the fragments are not redisplaced. By the end of a week the angle at which the elbow is fixed may be gradually increased. The splint should be worn for about three weeks, and the sling for a week or two longer.

*Separation of the epiphysis* and *fracture of the internal epicondyle* are treated on the same lines as supra-condylar fracture. It is, however, sometimes advantageous in the epicondylar fracture to fix the small fragment in position by a nail inserted through the skin.

T- or Y-*shaped fractures* and *fractures of the condyles*, inasmuch as they implicate the articular surfaces, present greater difficulties in treatment. In young subjects whose occupation entails free movement of the elbow-joint, it is generally advisable to expose the fracture by operation and secure the fragments in position by nails or wires. The details of the operation vary in different cases, and depend upon the line of obliquity of the fracture, and the disposition of the individual fragments, points which may usually be determined by the use of the X-rays. In performing the operation care must be taken to disturb the periosteum as little as possible, lest the nutrition of the fragments be interfered with. In the less complicated cases it is sometimes possible to fix the fragments in apposition by nails inserted through the skin. After operation a retentive apparatus similar to that employed for the supra-condylar fracture is applied, and the treatment is conducted on similar lines, modified only by the presence of a wound.

Operative interference is sometimes necessary for ankylosis or locking of the joint after the fracture is united, or to relieve the ulnar nerve when it is involved in callus.

### Fractures of the Upper End of the Ulna.

**Fracture of the olecranon process** is a comparatively common injury in adults. It usually follows a fall on the flexed elbow, and is believed to result from the direct impact, supplemented by the traction of the triceps muscle. In a few cases it has been produced by muscular action alone. The line of fracture usually passes through the tip of the process, less frequently through its middle, and but rarely through the base. It may be transverse, oblique, T- or V-shaped, but is rarely comminuted or compound (Fig. 132).

*Clinical Features.*—As the fracture almost invariably implicates the articular surface of the bone, there is considerable swelling from effusion of blood into the joint. The power of extending the forearm is impaired, and other symptoms of fracture are present. The amount of displacement depends upon the level of the fracture, and the extent to which the aponeurotic expansion of the triceps is torn. As the fracture is usually near the tip, the displacement is generally comparatively slight, the prolongation of the fibres of insertion of the triceps on to the lateral and posterior parts of the process holding the small fragment in position. When the line of fracture is nearer the base, however, the contraction of the triceps tends to separate the fragments widely, and a distinct gap, which is increased on flexing the elbow, may often be felt between them. The upper fragment may be palpated; and if the elbow is passively extended, the fragments may be brought into apposition, and crepitus elicited.

When the fracture is oblique and there is little displacement bony union may result, but in many cases the fragments are united only by fibrous tissue. Separation of the olecranon epiphysis is one of the rarest forms of epiphysial detachment (Poland).

The upper fragment sometimes forms attachments to the shaft of the humerus, and this leads to stretching of the fibrous band between the fragments.

*Treatment.*—Within recent years the tendency of surgical opinion has been towards operative treatment in fracture of the olecranon, particularly in young adults, where there is marked separation of the fragments.

It is still an open question, however, whether the results after

operation are better than those obtained by one or other of the non-operative measures to be described. It would appear that too much stress has been laid on the necessity of bringing the fragments into contact, and that too little attention has been paid to the importance of massage and movement in maintaining the functions of the muscles and of the joint.



Fig. 132.—T-shaped Fracture of Olecranon Process.

*Treatment by Apparatus.*—When the fracture passes through the tip of the process and there is little or no displacement, the application of a convergent spica bandage with the elbow in the rectangular position, and a sling, fulfils all requirements.

When the displacement is considerable, it is usually recommended that the arm should be almost, but not quite, fully extended, and a bandage applied from the fingers to the level of the axillary fold, the turns covering the elbow being applied in the form of a convergent spica to approximate the

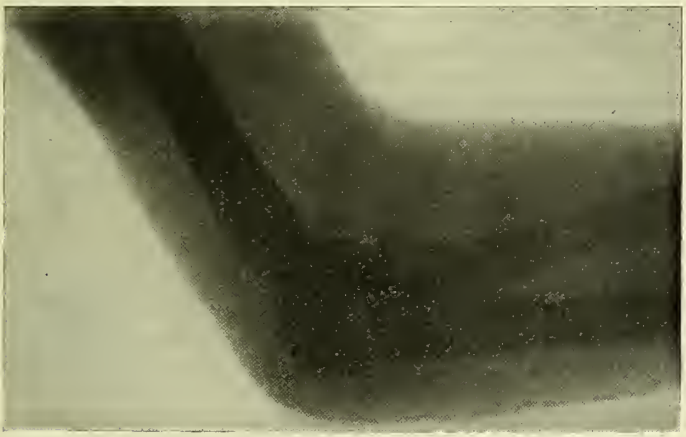


Fig. 133.—Radiogram of Fracture of Olecranon Process, showing moderate degree of displacement.

(Radiogram by Dr. Dawson Turner.)

fragments. A Gooch splint, extending from the lower border

of the axilla to the finger-tips, and cut to the shape of the extended limb (Fig. 134), is then applied anteriorly and fixed in position by a bandage, the region of the elbow being again covered in by a convergent spica.



Fig. 134.—Gooch Splint for Fracture of Olecranon. Note "carrying angle."

When the displacement is great, the fragments may be approximated by elastic extension. A large horse-shoe-shaped piece of adhesive plaster (Fig. 135) is applied to the back of the arm to make traction on the triceps, and is so arranged that it embraces the upper fragment. Attached to the plaster is a piece of strong elastic tubing. A bandage is then applied to the hand and forearm, and above the elbow is made to include the plaster and fix it in position. An anterior splint (Fig. 134) which is long enough to project a few inches beyond the finger-tips is next applied, and to the end of this the elastic tubing is fixed (Fig. 136). Some surgeons prefer to fix the elastic to the cuff of a strong dogskin glove applied to the hand. The extension apparatus is worn for about a week, after which massage and movement are commenced, and the arm is gradually flexed.

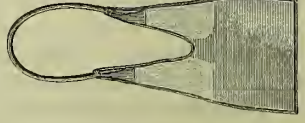


Fig. 135.—Horse-shoe-shaped Adhesive Plaster, with Elastic Tubing for Fracture of Olecranon.

When the fracture has been treated by prolonged immobilisation, in the extended position, stiffness of the joint persists for a considerable time, and may prove very intractable.

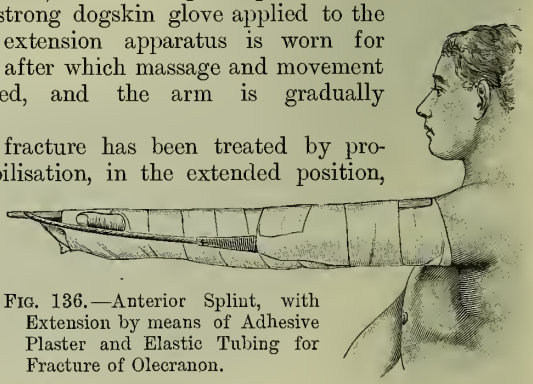


Fig. 136.—Anterior Splint, with Extension by means of Adhesive Plaster and Elastic Tubing for Fracture of Olecranon.

*Operative Treatment.*—A semilunar incision with its base above the tip of the olecranon is carried through the skin and fascia. The fracture is exposed, the joint cavity opened up and cleared of clots, and silver-wire sutures passed through the fragments without encroaching upon the articular cartilage. The limb

is fixed with the elbow-joint in the position of slight extension. Movement may be commenced at the end of a week, the angle at which the joint is fixed being changed morning and evening. During the day the joint should be flexed and the arm carried in a sling; during the night it should be extended and fixed to a pillow by the patient's side. The patient is allowed to use the joint cautiously within a fortnight.

*Old-standing Fractures.*—When firm union fails to take place, the interval between the fragments tends to increase by the contraction of the triceps gradually stretching the intermediate fibrous tissue, so that a wide gap comes to separate the fragments. If the function of the limb is impaired, the best treatment is to expose the fragments, refresh their edges, and wire them.

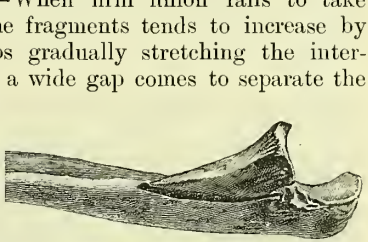


Fig. 137.—Fracture of Coronoid Process.

**Fracture of the coronoid process** is very rare except as a complication of backward dislocation of the elbow. It may be produced, however, by direct violence, as well as by muscular action. As the fracture is usually within a quarter of an inch of the tip, the fibres of insertion of the brachialis anticus tend to prevent displacement. The ordinary evidences of fracture are often absent, and the diagnosis is seldom completed without the aid of the X-rays. The treatment consists in flexing the elbow and supporting the forearm in a sling. In some cases associated with dislocation, however, the small fragment has been so far displaced as to become attached to the back of the condyles of the humerus (Annandale).

## Fractures of the Upper End of the Radius.

Intra-capsular fracture of the **head of the radius** may result from direct violence, from a fall on the pronated hand, or from forcible pronation or abduction—that is deviation of the forearm to the radial side. It may accompany dislocation of the elbow or fracture of adjacent bones. The head may be completely separated, or may be split into two or more fragments. Up to the seventeenth year the *epiphysis*, which is entirely intra-articular, may be separated.

The *clinical features* are localised pain, crepitus, interference with pronation and supination, and in some cases the fragment

may be felt through the skin, although it usually continues to move with the shaft in pronation and supination.

Union generally takes place satisfactorily, but in some cases the fragments form new attachments resulting in impaired movement at the elbow.

Fracture of the **neck of the radius** between the capsule and the tubercle is rare. These injuries are treated with the elbow in the flexed position, and massage and movement are carried out as already described.

## Dislocations of the Elbow.

Dislocations of the elbow-joint may involve one or both bones of the forearm, and may be complete or incomplete.



Fig. 138. — Backward Dislocation of Elbow, in a boy æt. 10, caused by a fall off a wall, landing on the elbow.

**Dislocation of both bones backward** is the most common of all dislocations of the elbow, and is the only dislocation in the body which is frequently met with in children. It usually results from a fall on the outstretched hand, causing hyper-extension of the joint with abduction—that is, lateral deviation towards the radial side; but it may follow a direct blow on the back of the humerus, a fall on the elbow, or a twist of the forearm.

*Morbid Anatomy.* — The anterior and lateral ligaments of the elbow are torn, while the posterior and orbicular ligaments remain intact. The radius and ulna pass backward, the coronoid process coming to rest opposite the olecranon fossa behind the humerus, and the head of the radius behind the external condyle. The condyles of the humerus bear their normal relations to one another. The olecranon process and triceps tendon form a marked prominence on the back of the elbow, the tip of the olecranon lying above and behind the

condyles. The lower end of the humerus lies in the flexure of the joint with the biceps tendon tightly stretched over it. The

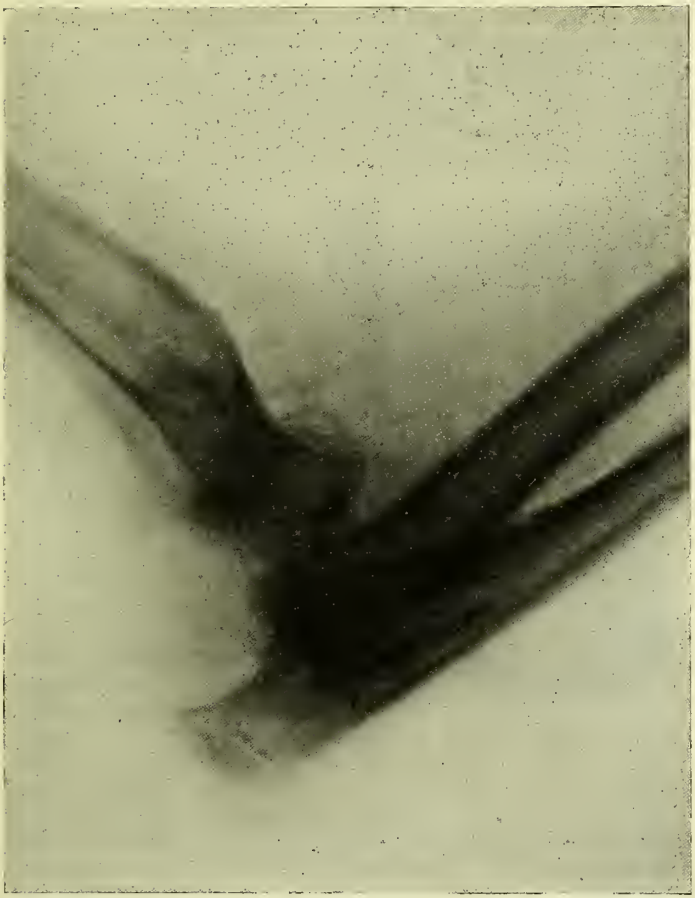


Fig. 139.—Radiogram of Complete Backward Dislocation of Elbow.
(Photograph by Dr. Dawson Turner.)

coronoid process is often broken, or the tendon of the brachialis anticus torn. The median and ulnar nerves may be stretched or torn. Not infrequently the bones of the forearm are displaced towards the inner side as well as backward (Fig. 139).

*Clinical Features.*—The elbow is held fixed at an angle of about 120°, pronated or midway between pronation and supination (Fig. 138). Any attempt at movement causes great pain, and is followed by an elastic rebound to the abnormal position. The antero-posterior diameter of the joint is increased, and the forearm, as measured from the external condyle to the tip of the styloid process of the radius, is shortened to the extent of about an inch. If examined before swelling ensues, the outlines of the articular surfaces may be recognised in their abnormal positions, but swelling usually comes on rapidly, and, by obscuring the bony landmarks of the joint, renders the diagnosis difficult.

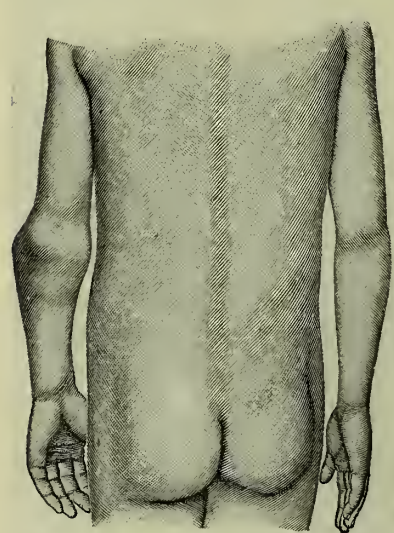


Fig. 140.—Backward and outward Dislocation of Bones of Forearm on Left Side, in a boy æt. 10.

This injury has to be diagnosed from supra-condylar fracture with backward displacement, and from separation of the lower humeral epiphysis. A general anæsthetic is often necessary to enable an accurate diagnosis to be made. When the deformity is once reduced, there is no tendency to its reproduction unless the coronoid process is at the same time fractured.

In a considerable number of cases—according to E. H. Bennett, in the majority—this dislocation is *incomplete*, the coronoid process resting at the level of the trochlea, and the backward projection of the olecranon being scarcely appreciable. The head of the radius, however, is unduly prominent. In such cases the lesion is liable to be overlooked, and therefore to go untreated, leading to permanent impairment of function of the joint.

**Dislocation forward** is much less common than the backward variety. It is produced by severe force acting from behind on the flexed elbow, the ulna being driven forward, tearing the ligaments of the joint and the muscles attached to the condyles. The olecranon process is frequently fractured at the same time.

When it remains intact it may rest below the condyles (incomplete or first stage of dislocation), or may pass in front of them, especially if the triceps is ruptured (complete or second stage). The forearm is lengthened, the elbow slightly flexed, the posterior aspect of the joint flattened, and the condyles and olecranon, in their abnormal relationship, can be palpated from behind.

**Lateral Dislocations.**—Dislocation towards the ulnar side—*inward*—is always incomplete, some portion of the articular surface of the bones of the forearm remaining in contact with the condyles.

The radial or *outward* dislocation is also incomplete as a rule, although cases have been recorded in which complete separation had taken place.

Both forms of lateral dislocation are rare, the inward variety being that more frequently observed. Each form is often combined with other injuries in the region of the joint.

The most common cause of these dislocations is a fall on the outstretched hand, the forearm at the moment being strongly pronated. Forced abduction favours the inward displacement; adduction the outward. The limb is held flexed and pronated, and the facility with which the bony points can be palpated renders the diagnosis easy.

In a few cases *diverging dislocations* have been met with, the radius and ulna being separated from one another, the orbicular ligament being torn and no longer holding them together.

**Treatment of Dislocations of Elbow.**—The chief obstacle to reduction in the *backward and lateral dislocations* is the spasmodic contraction of the muscles passing over the joint, and sometimes the hitching of the coronoid process against the edge of the olecranon fossa. In recent cases, to effect reduction the patient is seated on a chair, while the surgeon grasps the humerus and wrist, and places his knee in the bend of the elbow. The limb is first fully extended, or even hyperextended, to relax the triceps and free the coronoid process. Traction is then made in opposite directions upon the forearm and upper arm, the surgeon's knee meanwhile making pressure, in a backward direction, upon the lower end of the humerus. The joint is next slowly flexed, and the bones slip into position, often with a distinct snap. If the patient be anæsthetised these manipulations must be adapted to the recumbent position. When some days have elapsed before reduction is attempted, adhesions must be broken down by flexing, extending, and laterally moving the joint, under an anæsthetic, before the above manipulations are carried out.

After reduction, the limb is flexed to rather less than a right angle, fixed in a posterior moulded splint, and supported by a sling. Massage and movement are commenced in a day or two, and the splint may be dispensed with at the end of a week.

Fracture of the coronoid process predisposes to recurrence of the dislocation; when this complication exists, therefore, the limb should be fixed at an acute angle, and movements postponed for a fortnight. Massage, however, may be carried out after the first few days.

If there is a fracture of the olecranon process, the treatment must be modified accordingly (p. 478).

Comminuted and compound injuries usually call for operative treatment, the fractured bones being wired after reduction of the dislocation, or the loose fragments removed.

The *forward dislocation* is reduced by fully flexing the elbow,

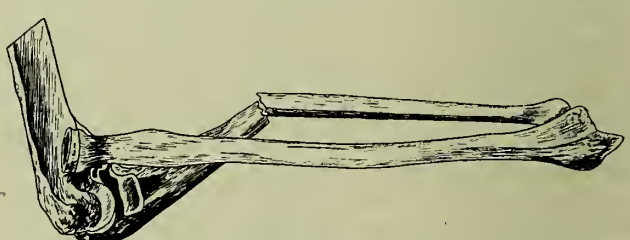


Fig. 141.—Forward Dislocation of Head of Radius, with Fracture of Upper Third of Shaft of Ulna.

and then pushing the bones of the forearm backward, while the humerus is pulled forward.

*Old-standing Dislocations.*—It is seldom possible to reduce by manipulation a dislocation of the elbow which has remained displaced for five or six weeks, especially when it has been complicated by a fracture. The joint surfaces become welded together by adhesions, and separated fragments often form attachments which completely lock the joint. Attempts to break these down are attended with considerable risk of re-fracturing the bone or of tearing soft parts. In such cases it is best to expose the joint and to remove sufficient bone to provide a movable and useful joint.

**Dislocation of the ulna alone** is a rare injury, and is usually associated with fracture of one or other of its processes or of the internal condyle.

**Dislocation of the radius alone**, on the other hand, is com-

paratively common, especially as a concomitant of fracture of the upper third of the shaft of the ulna (Fig. 141).

The injury may result from a blow on the back of the upper end of the radius, a fall on the outstretched hand, or, in children,

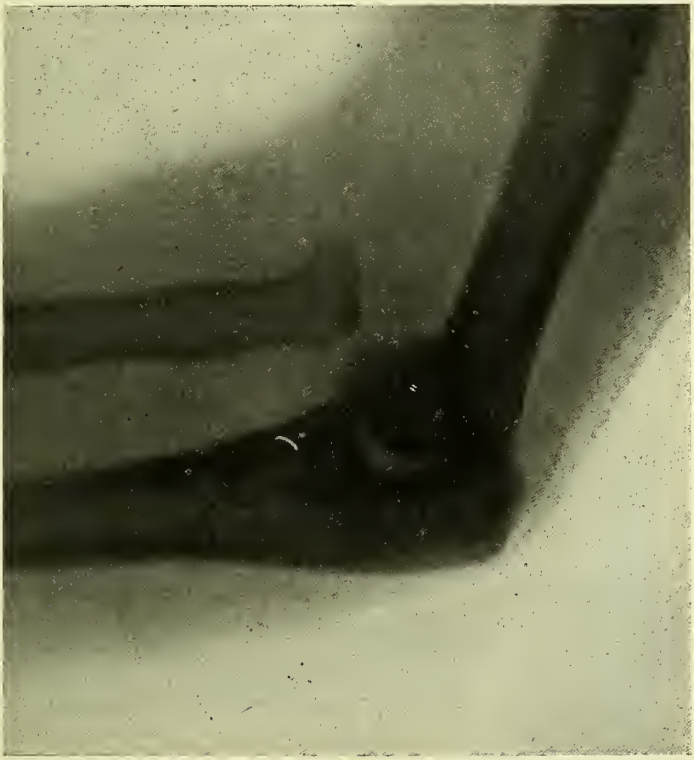


Fig. 142.—Radiogram of Forward Dislocation of Radius.
(Mr. David Wallace's case.)
(Photograph by Dr. Dawson Turner.)

from forcibly dragging the forearm while in the pronated position. The displaced head usually passes *forward*, and rests on the anterior edge of the capitellum, thus preventing complete flexion and supination of the limb.

The limb is flexed and pronated. The displaced head of the radius can be felt to rotate with the shaft in its abnormal position, and the articular facet on the head of the radius may

also be felt; there is a depression below the external condyle where the head should be. The radial side of the forearm is slightly shortened.

In a few cases the displacement of the head has been *backward* or *outward*.

*Treatment.*—To effect reduction the forearm should be alternately flexed and extended, while traction is made upon it from the wrist, and the head of the radius is pressed backward with the thumb in the fold of the elbow. When reduction is prevented by the interposition of a portion of the torn ligaments between the bones, it is sometimes necessary to open the joint to ensure accurate adjustment. The joint is fixed in acute flexion, to allow of union of the torn ligaments and to prevent recurrence.

In old-standing cases, to obtain a useful joint, resection of the head of the radius may be necessary.

**Sub-luxation of the head of the radius**, or "dislocation by elongation," is a comparatively common injury in children between the ages of two and six. It almost invariably results from the child being lifted or dragged by the hand or forearm. The traction and torsion thus put upon the radius causes the front part of its head to pass out of the orbicular ligament, the edge of which slips between the bones.

The person holding the child may feel a click at the moment of displacement. The child complains of pain in the region of the elbow; the arm at once becomes useless, and is held flexed, midway between pronation and supination. All movements are painful, but especially movements in the direction of supination. The deformity is slight, but the head of the radius may be unduly prominent in front. From the way in which the injury is produced the wrist also is often swollen, and in some cases the patient is brought to the surgeon on account of the condition of the wrist, and attention is not directed to the elbow.

*Treatment.*—Spontaneous reduction frequently takes place, the function of the arm being at once completely restored. In other cases it is necessary, under anæsthesia, to manipulate the head of the bone into position. This is usually easily done by flexing the elbow, making slight traction on the forearm, and alternately pronating and supinating it. After reduction a few days' massage is all that is necessary, the joint in the intervals being kept at rest in a splint and sling.

**Sprain** of the elbow is comparatively common as a result of a fall on the hand or a twist of the forearm. The point of

maximum tenderness is usually over the radio-humeral joint, the external lateral and orbicular ligaments being those most frequently damaged. Effusion takes place into the synovial cavity, and a soft, puffy swelling fills up the natural hollows about the joint. The bony points about the elbow retain their normal relationship to one another—a feature which aids in determining the diagnosis between a sprain and a dislocation or fracture. In children it is often difficult to distinguish between a sprain and the partial separation of an epiphysis. Sprains of the elbow are treated on the same lines as similar lesions elsewhere—by massage and movement. The condition known as *tennis elbow* is characterised by severe pain over the insertion of the pronator radii teres during the act of pronation, and is due to stretching or tearing of the fibres of that tendon, and of the adjacent intermuscular septa. A similar injury—*sculler's sprain*—occurs in rowing men from feathering the oars. The treatment consists in massage and movement, care being taken to avoid the movements which produced the injury. In persistent cases blistering may be useful.

## Fractures of the Forearm.

The *shafts* of the bones of the forearm may be broken separately, but it is much more common to find both broken together.

**Fracture of both bones** may result from a direct blow, from a fall on the hand, or from their being bent over a fixed object. The line of fracture is usually transverse, both bones giving way about the same level. The common situation is near the middle of the shafts. In children, greenstick fracture of both bones is a frequent result of a fall on the hand—this indeed being one of the commonest examples of greenstick fracture met with (Fig. 143).

The *displacement* varies widely, depending partly upon the force causing the fracture, partly on the level at which the bones break and on the muscles which act on the respective fragments. It is common to find an angular displacement of both bones to the radial or to the ulnar side. In other cases the four broken ends impinge upon the interosseous space, and may become united to one another, preventing the movements of pronation and supination. There may be shortening from overriding of fragments.

When the radius is broken above the insertion of the

pronator radii teres, its upper fragment may be supinated by the biceps and supinator brevis, while the lower fragment remains in the usual semi-prone position. If union takes place in this position the power of complete supination is permanently lost.

The usual *symptoms* of fracture are present, and there is seldom any difficulty in diagnosis.

The *prognosis* must be guarded, especially with regard to the preservation of pronation and supination. These movements may be interfered with if union takes place in a bad position with angular or rotatory deformity of one or both bones, or if callus is formed in excess and causes locking of the bones. In some cases the callus fuses the two bones across the interosseous space and pronation and supination are rendered impossible.

Persistent angular deformity of the forearm is also liable to



Fig. 143.—Greenstick Fracture of both Bones of the Forearm.

ensue, either from failure to correct the displacement primarily, or from subsequent bending due to ill-applied splints or slings. Want of union, or the formation of a false joint in one or both bones, is sometimes met with, and seriously impairs the usefulness of the limb.

A considerable number of cases of gangrene of the limb after simple fracture of the forearm are on record. This is sometimes attributable to damage inflicted upon the blood-vessels by the fractured bones, or to the force which caused the fracture, but is oftener due to a roller bandage applied underneath the splints strangulating the limb, to injudiciously applied pads, or to too tight bandaging over the splints.

In uncomplicated cases union takes place in from three to four weeks.

*Treatment.*—To ensure accurate reduction and coaptation a

general anæsthetic is usually necessary. In the greenstick variety the bones must be completely straightened, the fracture being rendered complete, if necessary, for this purpose.

To retain the bones in position anterior and posterior wooden splints are then applied. These are made to overlap the forearm by about half an inch on each side, to avoid compressing the forearm laterally and so making the fractured ends encroach upon the interosseous space. The dorsal splint is usually made to extend from the olecranon to the knuckles, and the palmar one from the bend of the elbow to the flexure in the middle of the palm, a piece being cut out to avoid pressure on the ball of the thumb (Fig. 144). The splints are applied with the elbow flexed to a right angle, and, except when the radius is broken above the level of the insertion of the pronator radii teres, with the forearm midway between pronation and supination. An external rectangular splint is then applied, and the limb supported by a sling, so adjusted that it supports equally the hand and elbow, in order to avoid angular deformity. The use of special interosseous pads is to be avoided, as they are liable to cause gangrene of the skin.

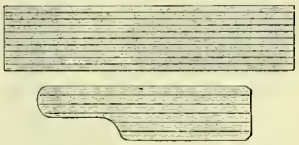


Fig. 144.—Gooch Splints for Fracture of both Bones of Forearm. (These are applied with the wooden side towards the skin.)

When the fracture of the radius is above the insertion of the

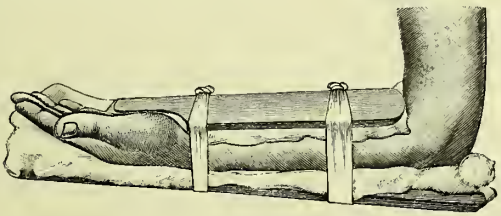


Fig. 145.—Splints applied for Fracture of Forearm.

pronator radii teres, the forearm should be fixed in the position of complete supination with the elbow flexed to an acute angle, and retained in this position by moulded anterior and posterior splints. This position is very irksome to the patient, and great care is necessary in the adjustment of the apparatus to prevent pronation.

Massage and movement should be carried out early. It is

usually necessary to continue wearing the splints for about three weeks.

In cases of *mal-union*, especially when the bones are ankylosed to one another across the interosseous space, operation may be necessary, but it is neither easy in its performance nor always satisfactory in its results. The seat of fracture should be exposed by one or more incisions so placed as to enable the muscles to be separated and to give access to the callus. When the limb is straight it is only necessary to gouge away the exuberant callus which interferes with rotatory movements; but when there is an angular deformity (Fig. 146) the bones must, in addition, be divided and reset, and, if necessary, wired in good position. In comparatively recent cases it is sometimes possible without operation to refracture the bones, and to set them anew.



Fig. 146.—Badly united Fracture of both Bones of Forearm. Boy æt. 11. Probably an unreduced greenstick fracture.

*Un-united fracture* of the bones of the forearm is treated on the usual lines.

**Fracture of the shaft of the radius alone** may be due to a direct blow; to indirect violence, such as a fall on the hand, or the recoil of the lever in starting the engine of a motor car; or to forcible pronation against resistance, as in wringing clothes. It is rare in comparison with fracture of both bones. When broken above the insertion of the pronator radii teres, the upper fragment is flexed and supinated by the biceps and supinator brevis, while the lower fragment remains semiprone, and is drawn towards the ulna by the pronator quadratus.

When the fracture is below the pronator radii teres the displacement depends upon the direction of the force and the obliquity of the fracture. In fractures of the lower third of the shaft, the hand may be flexed toward the radial side, raising the styloid process, as in a Colles' fracture.

In addition to the ordinary signs of fracture, there is partial or complete loss of pronation and supination. The head of the radius as a rule does not move with the lower part of the shaft, but may do so if the fracture is incomplete or impacted.

**Fracture of the shaft of the ulna alone** is also comparatively rare. It is almost always due to a direct blow sustained while protecting the head from a stroke, or to a fall on the ulnar edge of the forearm, as in going up a stair.

The upper third is most frequently broken, and this injury is often associated with dislocation of the head of the radius, or some other injury implicating the elbow-joint. On account of the superficial position of the bone this fracture is frequently compound.

The displacement depends on the direction of the force, the fragments being usually driven towards the interosseous space. There is seldom marked deformity unless the head of the radius is dislocated at the same time. The diagnosis is, as a rule, easy.

The *treatment* is the same as for fracture of both bones, but the splints may be dispensed with at the end of a fortnight.

# CHAPTER XXIV.

## INJURIES IN THE REGION OF THE WRIST AND HAND.

Surgical Anatomy—Fractures of Lower End of Radius: *Colles' fracture; Smith's fracture; Longitudinal fracture; Separation of epiphysis*—Fractures of Lower End of Ulna: *Shaft; Styloid process; Separation of epiphysis*—Fractures of Carpal Bones—Dislocations: *Inferior radio-ulnar joint; Radio-carpal joint; Carpal bones; Carpo-metacarpal joint*—Sprains.

### Injuries in the Region of the Wrist.

These include fractures of the lower ends of one or of both bones of the forearm, or separation of their epiphyses; dislocations and sprains of the inferior radio-ulnar, and of the radio-carpal articulations; and fractures and dislocations of the carpus.

**Surgical Anatomy.**—The most important landmarks in the region of the wrist are the styloid processes of the radius and ulna. The tip of the radial styloid is palpable in the "anatomical snuff-box" between the tendons of the extensor brevis and extensor longus pollicis, and it lies about half an inch lower than the ulnar styloid. The ulnar styloid is best recognised on making deep pressure a little below and in front of the head of the ulna, which forms the rounded subcutaneous prominence seen on the back of the wrist when the hand is pronated.

The tubercle of the scaphoid and the trapezium can be felt at the base of the ball of the thumb, a little below the radial styloid; and the pisiform and hook of the unciform are palpable, slightly below and in front of the ulnar styloid.

In examining an injured wrist the different bony points should be located, and their relative positions to one another and to the adjacent joints noted. The particular shape, position, and relations of any unnatural projection or depression should likewise be carefully observed. The power and range of movement—active and passive—at the various joints should also be tested.

### Fractures of the Lower End of the Radius.

**Colles' Fracture.**—This fracture, which was first described by Colles of Dublin in 1814, is one of the commonest fractures

in the body, and is especially frequent in women beyond middle age. It is almost invariably the result of a fall on the palm of the hand, in the three-quarters pronated position (Fullerton), the force being received on the ball of the thumb, and transmitted through the carpus to the lower end of the radius. "If at the moment of impact the angle between the axis of the forearm and ground is less than 60°, the line representing the direction of the force passes upwards in front of the axis of the forearm; the whole shock is therefore borne by the lower end of the radius, which is broken off, and the force being continued, the lower fragment is driven backwards" (Chiene).



FIG. 147.—Colles' Fracture, in a man æt. 30, from a fall on the palm. "Inverted-spoon" deformity well marked.

The fracture takes place through the cancellated extremity of the bone, within a half to three-quarters of an inch of its

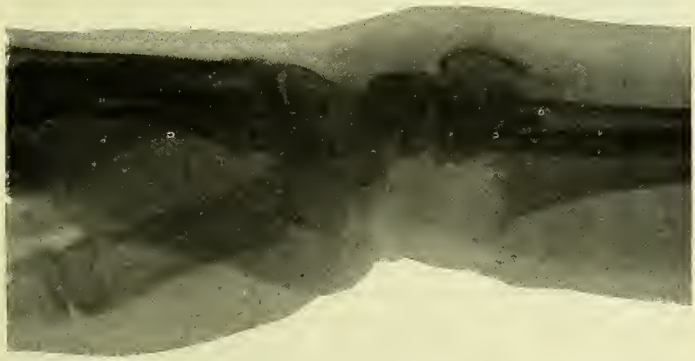


FIG. 148.—Radiogram of Colles' Fracture in woman æt. 50. Lateral view.
(Mr. J. W. Struther's case.)
(Photograph by Dr. F. K. Kerr.)

articular surface (Fig. 148). It is usually transverse, but may be slightly oblique, from above downwards and from without inwards. In a considerable proportion of cases it is impacted, and not infrequently the lower fragment is comminuted, the fracture extending into the radio-carpal joint.

When impaction takes place it is usually reciprocal, the dorsal

edge of the upper fragment piercing the lower fragment, and the palmar edge of the lower fragment piercing the upper. The mechanism producing comminution of the lower fragment is practically constant, the upper fragment being forced as a wedge into the lower, taking effect first and chiefly on the side of the fragment next the ulna (E. H. Bennett). The periosteum is usually torn and stripped from the palmar aspect of the fragments, while it remains intact on the dorsum.

In the majority of cases the styloid process of the ulna is torn off by traction exerted through the internal lateral ligament.



Fig. 149.—Colles' Fracture. From same patient as Fig. 147. Shows radial deviation of corpus; slight ulnar deviation of fingers; and undue prominence of ulnar styloid.

The resulting *displacement* is of a threefold character: (1) the lower fragment is displaced backwards; (2) its carpal surface is rotated backwards on a transverse diameter of the forearm; while (3) the whole fragment is rotated upward through the arc of a circle, the centre of which is situated at the ulnar attachment of the triangular ligament, the radius of the circle being a line from the ulnar attachment of the triangular ligament to the tip of the styloid process of the radius: stated more simply, the radial styloid is tilted so that it comes to lie at a higher level than normal (Chiene).

*Clinical Features.*—In a typical case there is a marked prominence on the back of the wrist, caused by the displaced lower fragment, with a depression just above it (Fig. 147); and the wrist is broadened from side to side. The natural hollow on the palmar aspect of the radius is filled up by the projection of the upper fragment. The carpus is carried to the radial side by the upward rotation of the lower fragment (Fig. 149), and the radial styloid is raised so that it lies as high, or even higher, than that of the ulna. The lower end of the ulna is rendered unduly prominent by the flexion of the hand to the radial side. The fingers are partially flexed and slightly deviated towards the ulnar side; and the patient supports the injured wrist in the palm of the opposite hand, and avoids movement of the part.

The general outline of the wrist and hand has been compared not inaptly to that of "an inverted spoon." Pronation and

supination are lost, the joint is swollen, and there is tenderness on pressure, especially over the line of fracture. Tenderness over the position of the ulnar styloid may indicate fracture of that process, although it is sometimes present without fracture, and has been absent in cases where a fracture was demonstrated by the Röntgen rays (Cathcart). No attempt should be made to elicit crepitus in a suspected case of Colles' fracture, as the manipulations are extremely painful, and are liable to increase the displacement. As a matter of fact it may be wanting in any form of this injury. Its absence, further, is not to be accepted as proving impaction.

*Treatment.*—It cannot be too strongly insisted upon that success in the treatment of Colles' fracture depends chiefly upon complete and accurate reduction. As considerable force may be necessary, especially when impaction exists, a general anæsthetic is of great assistance. The surgeon grasps the patient's hand, as if shaking hands with him, and resting the palmar surface of the wrist on his bent knee, makes firm traction through the hand, and counter-extension through the forearm, with lateral movements, if necessary, to undo impaction. When the fragments are freed from one another the wrist is flexed, and the hand carried to the ulnar side, while the fragments are moulded into position. When reduction is complete the deformity almost entirely disappears, and the two styloid processes regain their normal positions relative to one another.

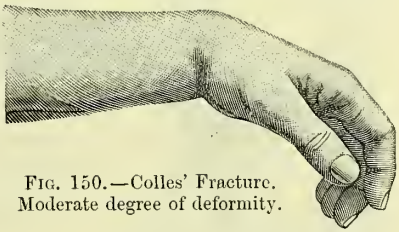


Fig. 150.—Colles' Fracture. Moderate degree of deformity.

As there is no tendency to redisplacement, the simplest possible retentive apparatus should be applied. A firm flannel bandage, a broad strip of adhesive plaster, or a poroplastic wristlet is usually sufficient. In some cases, however, a dorsal splint padded so as to flex the wrist to an angle of 45° (P. Heron Watson); or anterior and posterior splints, similar to those used for fracture of both bones of the forearm, but somewhat narrower, may be employed, as they add to the patient's comfort and sense of security. The hand and forearm are in any case supported in a sling.

To avoid the stiffness which often follows this fracture, the fingers should be freely moved from the first, and massage and movement of the wrist commenced within the first few days,

and carried on till movement is perfect. If splints are used they should be discarded in a week or ten days, and the patient is then encouraged to use the wrist freely.

The various special splints recommended for the treatment of Colles' fracture, such as Carr's, Gordon's, the "pistol splint," and many others, are all designed to correct the deformity as well as to control the fragments. It has already been pointed out that if reduction is complete there is no deformity to correct, and if it is not complete the deformity cannot be corrected by any form of splint.

*Unreduced Colles' Fracture.*—When union has been allowed to take place without the displacement having been reduced, an unsightly deformity results. In young subjects whose occupation is likely to be interfered with, and in women for æsthetic reasons, the bone may be divided with an osteotome, and set in



FIG. 151.—Smith's Fracture of Radius, united in deformed attitude.

(Museum of Royal College of Surgeons, Edinburgh.)

the normal position. As a rule, however, the usefulness of the limb is not interfered with, and operative measures are rarely called for.

A fracture of the lower end of the radius *with forward displacement of the carpal fragment*, was first described by R. W. Smith of Dublin (Fig. 151) (*Colles' fracture reversed* or **Smith's fracture**). It is nearly always due to forcible flexion, as from a fall on the back of the hand. Like Colles' fracture, it may be transverse or slightly oblique, impacted, or comminuted. The deformity is characterised by an elevation on the dorsum running obliquely upwards from the ulnar to the radial side of the wrist, and caused by the head of the ulna, which remains in position, and the lower end of the upper fragment. Below this, over the position of the lower radial fragment, is a gradual slope on to the dorsum of the hand. Anteriorly there is a prominence in the flexure of the wrist, and the lower fragment may be felt under the flexor tendons. The hand deviates to the radial side, and thereby still further increases the prominence caused by the lower end of the ulna. The radial

styloid is displaced forward, upward, and to the radial side, and the ulnar styloid may be torn off. Crepitus can seldom be elicited.

When the deformity is not well marked, this injury may be mistaken for forward dislocation of the wrist, for fracture of both bones low down, or for sprain of the joint.

The *treatment* is carried out on the same lines as in Colles' fracture.

*Longitudinal fractures* of the lower end of the radius opening into the joint usually result from the hand being crushed by a heavy weight or in machinery. They are often compound and comminuted.

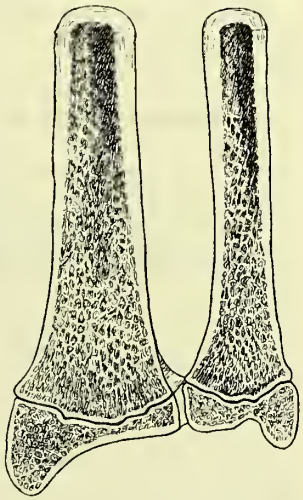


Fig. 152. —Section of lower end of Radius and Ulna to show line of Epiphyses.

(After Poland.)

**Separation of the lower epiphysis** of the radius is comparatively common between the ages of seven and eighteen, especially in boys, and is caused by the same forms of violence as produce Colles' fracture. The epiphysis, which is on the same level as that of the ulna (Fig. 152), lies above the level of the synovial membrane of the wrist-joint.

Although the clinical appearances in these two injuries bear a general resemblance to one another, separation of the epiphysis may usually be identified by the directly transverse line of the dorsal and palmar projections, the folding of the skin observed in the palmar depression, the absence of abduction of the hand, and the ease with which muffled crepitus can be elicited (E. H. Bennett). The deformity is readily reduced, and the fragments are easily retained in position.

This injury is often complicated with fracture of the shaft or styloid process of the ulna, or with dislocation of the radio-ulnar joint, and it is not infrequently compound. Interference with the growth of the radius seldom occurs ; when it does it results in a valgus condition of the hand, calling for resection of the lower end of the ulna.

The *treatment* is the same as for Colles' fracture.

**Fractures of the Lower End of the Ulna.**—The lower end of the *shaft* of the ulna is seldom fractured alone. The *styloid process*, as has already been pointed out, is frequently broken in association with Colles' and other fractures of the lower end of the radius.

Separation of the *lower epiphysis* of the ulna sometimes occurs, and in rare cases results in arrest of the growth of the ulna, leading to a varus condition of the hand and bending of the radius.

The *treatment* is similar to that for Colles' fracture.

Simultaneous separation of the *epiphyses of both radius and ulna* sometimes occurs, and, as a result of severe violence, may be compound, the lower ends of the diaphyses projecting through the skin on the dorsum.

**Fractures of Carpal Bones.**—The use of the Röntgen rays has shown that fracture of individual carpal bones is a commoner injury than has hitherto been supposed, and that many cases formerly looked upon as severe sprains are examples of this injury. The scaphoid is broken more frequently than any of the others, usually by direct violence or by forced dorsiflexion. The clinical features are: localised swelling on the radial side of the wrist, marked tenderness in the anatomical snuffbox when the hand is moved laterally, and, sometimes, crepitus. In many cases, however, the symptoms are so obscure that an accurate diagnosis can only be made by the use of the X-rays. In many cases the fracture is compound and associated with other injuries, particularly forward dislocation of the semilunar bone.

The *treatment* of simple fractures consists in fixing the wrist and carpal joints by a palmar splint, the metacarpals being slightly hyper-extended. When the fracture is compound the loose fragments should be removed. Codman and Chase recommend excision of the proximal half of the fractured bone.

## Dislocations in the Region of the Wrist.

The strong ligaments of the articulations about the wrist, the comparatively free movement at the various joints, and the relative weakness of the lower end of the radius whereby it is so frequently fractured, render dislocation a rare form of injury.

Dislocation may occur at the inferior radio-ulnar, the radio-carpal, mid-carpal, inter-carpal, or carpo-metacarpal joints.

Dislocation of the **inferior radio-ulnar** articulation is seldom met with except as a complication of fracture of the lower end

of the radius, or in association with sub-luxation of the head of the radius. The head of the ulna usually passes backward, less frequently forward, and but rarely towards the ulnar side.

In children, the commonest cause is lifting the child by the hand, and the displacement, as a rule, is only partial.

In adults, it may result from forcible efforts at pronation or supination, as in wringing clothes, or from direct violence, the separation being frequently complete and sometimes compound.

The head of the ulna forms a prominence on the dorsal or palmar aspect of the wrist, according to the direction in which it passes, and there is an undue depression on the opposite aspect of the joint. The hand is generally pronated, the rotatory movements at the wrist being restricted and painful, while flexion and extension are comparatively free. When uncomplicated the dislocation is easily recognised, but when complicated with fracture it is apt to be overlooked.

Reduction is readily effected by making direct pressure on the displaced bone and manipulating the joint, especially in the direction of supination.

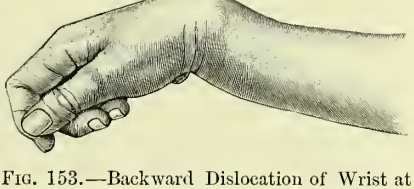


Fig. 153.—Backward Dislocation of Wrist at Radio-Carpal Articulation, in a man æt. 24, from a fall of 15 feet, landing on back of knuckles.

Dislocation at the **radio-carpal** articulation, or "dislocation of the wrist," is that most commonly met with in this region. It is often complicated by fracture of the lower ends of the bones of the forearm; is attended by great tearing of the ligaments and displacement of tendons; and is frequently compound. The carpus may be displaced backward or forward, and the separation is usually complete. It is not uncommon for that articular edge of the radius towards which the carpus passes to be chipped off.

In most cases the carpus is dislocated *backward*, and the injury results from a severe form of violence, such as a fall from a height on the palm while the hand is dorsiflexed and abducted.

The clinical appearances closely simulate those of Colles' fracture, or of separation of the lower radial epiphysis, but the unnatural projections, both in front and behind, are lower down, and end more abruptly (Fig. 153). The hand is more flexed, and the palm is shortened. The styloid processes retain their normal relations to one another, but that of the radius is nearer to the thumb than it should be, and the carpal bones are found

to lie on a plane posterior to the styloids. The radius is not shortened. Unless the swelling is great the articular surfaces may be recognised on palpation.

Dislocation of the carpus *forward* may result from any form of forced flexion, such as a fall on the back of the hand, or from direct violence. The displaced carpus forms a marked projection on the palmar aspect of the wrist, and there is a corresponding depression on the dorsum. The attitude of the hand and fingers varies, but is usually one of flexion. In other respects this dislocation agrees with the dorsal variety.

In both varieties, reduction is readily effected by making traction on the hand and pushing the carpus into position. An anterior splint which keeps the hand slightly dorsiflexed is worn for about a fortnight, movement and massage being employed from the first.

**Dislocation of Carpal Bones.**—The two rows of carpal bones may be separated from one another, or any one of the individual bones may be displaced. These injuries are rare, and result from severe forms of violence. Pain, deformity, and loss of function are the ordinary symptoms. The treatment consists in making direct pressure over the displaced bones, while traction is made on the hand, which is alternately flexed and extended. Of these injuries that most frequently observed is displacement of the *head of the os magnum* from the scaphoid and semilunar bones. In full palmar flexion of the wrist the displaced head of the os magnum forms a prominence on the dorsum opposite the base of the third metacarpal, which temporarily disappears when the hand is dorsiflexed. By keeping the hand in the dorsiflexed position for a week or ten days, the bone becomes fixed in its place and the function of the wrist is restored.

The *semilunar* may be displaced forward by forcible dorsiflexion of the hand, and forms a swelling over the inferior radio-ulnar joint, under the flexor tendons; there is usually loss of sensibility in the distribution of the ulnar nerve in the hand. The only satisfactory treatment is removal of the bone.

In a few cases the *scaphoid* has been displaced, and subsequently replaced by operation. Separation of any of the other bones is extremely rare.

**Carpo-metacarpal Dislocations.**—Any or all of the metacarpal bones may be separated from the carpus by forced movements of flexion or extension. The commonest displacement is backward. The thumb seems to suffer oftener than the other digits. These injuries, however, are so rare, and the

deformity is so characteristic, that a detailed description is unnecessary.

There is good reason to believe that the injury commonly described as "incomplete dislocation" or "sub-luxation of the metacarpal of the thumb backward" is really a fracture of the anterior portion of the base of the bone—an injury now known as Bennett's fracture (p. 504).

**Sprain of the wrist** is a common injury and results from a fall on the hand or a twisting form of violence. The marked swelling which rapidly ensues may render it difficult to distinguish a sprain from the more severe injuries which are liable to result from similar causes—Colles' fracture, separation of the lower radial epiphysis, and dislocation of the wrist.

In a sprain the normal relations of the styloid processes and other bony points about the wrist are unaltered, and there is no radial deviation of the hand, as in Colles' fracture. The most marked swelling is over the line of the articulation on the anterior and posterior aspects of the joint. There is usually some effusion into the sheaths of the tendons passing over the joint, and in some cases on moving the fingers a peculiar creaking, which may simulate crepitus, can be elicited. There is marked tenderness on making pressure over the line of the joint, as well as over one or other of the lateral ligaments, depending upon which has been overstretched or torn. Movements which tend to put the damaged ligaments on the stretch also cause pain. It has to be borne in mind, however, that in many cases of Colles' fracture there is extreme tenderness on pressing over the ulnar styloid and external lateral ligament, as these structures are frequently injured as well as the radius, but the point of maximum pain and tenderness is over the seat of fracture of the radius.

The *treatment* consists in the early employment of massage and movement, supplemented by alternate hot and cold douches, on the same lines as in other sprains.

## Injuries of the Fingers.

**Fractures.**—*Fractures of the metacarpals* of the four inner fingers are comparatively common. When they result from direct violence, such as a crush between two heavy objects, they are often multiple and compound. Indirect violence, acting in the long axis of the bone and increasing its natural curve, such as a fall or a blow on the knuckle, as in striking with the closed fist, usually produces an oblique fracture about the middle of

the shaft, the proximal end of the distal fragment projecting towards the dorsum of the hand. Apart from this there is little deformity, as the adjacent metacarpals act as natural splints and tend to retain the fragments in position. A sudden sharp pain may be elicited at the seat of fracture on making pressure in the long axis of the finger; and unnatural mobility and crepitus may usually be detected. These fractures are readily recognised by the X-rays. Firm union usually results in three weeks.

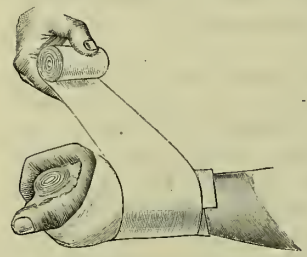


FIG. 154.—Treatment of Fracture of Metacarpals by Pad in the Palm and "Closed-fist" Bandage.

*Treatment.*—When the fracture is transverse, and especially when it implicates the middle or ring fingers, the most convenient method of treatment is to make the patient grasp a firm pad, such as a roller bandage covered with a layer of wool, and to fix the closed fist by a figure-of-eight bandage (Fig. 154). In this way the adjoining metacarpals are utilised as lateral splints. To prevent the extensor tendon forming attachments to the broken bone, active and passive movements must be carried out daily, and the bandage may be removed at the end of a fortnight.

In oblique fractures with a tendency to overriding of the fragments, especially in the case of the index and little fingers, it is sometimes necessary to apply extension to the distal segment of the digit, by means of adhesive plaster, to which elastic tubing is attached and fixed to the end of a rectangular splint reaching well beyond the finger-tips (Fig. 155) (Chiene). This should be worn for a week or ten days, passive movement being carried out daily after the first week.

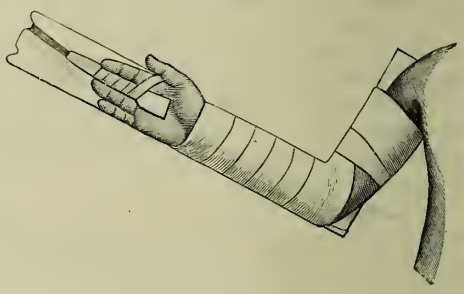


FIG. 155.—Extension applied for Oblique Fracture of Metacarpal.

**Bennett's Fracture of the Base of the first Metacarpal Bone.**—Bennett of Dublin has described an injury of the thumb,

which, although comparatively common, is often mistaken for a sub-luxation backward of the carpo-metacarpal joint, or a simple. "stave of the thumb." It consists in an "oblique fracture



Fig. 156.—Radiogram of Bennett's Fracture of Base of Metacarpal of Left Thumb.

(Mr. J. W. Struthers' case.)

(Photograph by Dr. F. K. Kerr.)

through the base of the bone, detaching the greater part of the articular facet with that piece of the bone supporting it which projects into the palm" (Fig. 156).

It results from severe force applied directly to the point of the thumb, driving the metacarpal against the trapezium, and

chipping off the palmar part of the articular surface. The rest of the metacarpal slips backward, forming a prominence on the dorsal aspect of the joint. The pain and swelling in the region of the fracture often prevent crepitus being elicited, and as the deformity is not at once evident the nature of the injury is liable to be overlooked. The fracture is readily recognised by the use of the X-rays. It may occur in either hand, but on account of the greater exposure of the right hand to injury it is commoner on that side. The importance of making a correct diagnosis lies in the fact that unless properly treated this injury frequently results in prolonged, or even permanent impairment of function, full abduction and fine movements requiring close opposition of the thumb being specially interfered with.



FIG. 157.—Splint for Fracture of Base of Metacarpal of Thumb.

The *treatment* consists in reducing the fracture by extension, and applying an accurately fitting pad over the extremity of the displaced bone, maintained in position by a light angular splint (Fig. 157). This splint is first fixed to the extended and abducted thumb, and while extension is made by pushing it downwards the upper end is fixed to the wrist (Fig. 158, A). The apparatus is worn for three weeks, being carefully readjusted from time to time to maintain the extension. A moulded poroplastic splint applied on the same principle may be employed (Fig. 158, B). Massage and movement should be commenced within a few days of the injury.

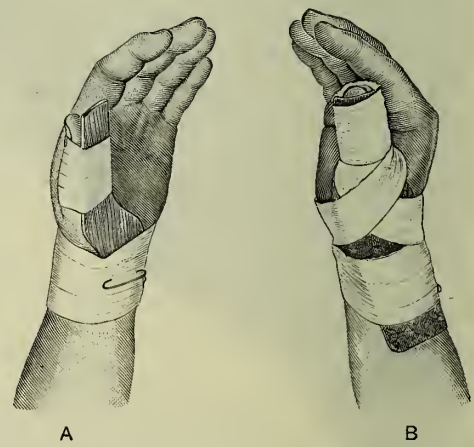



FIG. 158.—*A*. Splint applied as used by Bennett. *B*. Poroplastic Moulded Splint for Bennett's Fracture.

**Fractures of phalanges** usually result from direct violence,

and, on account of the superficial position of the bones, are often compound, and attended with much bruising of soft parts. Force applied to the distal end of the finger also may fracture a phalanx. The proximal phalanges are broken oftener than the others. The deformity is usually angular, with the apex towards the palm, and if union takes place in this position, flexion and grasping are interfered with. Unnatural mobility and crepitus can usually be recognised, but, on account of the swelling and tenderness, diagnosis is sometimes very difficult. Firm union takes place in two or three weeks. In oblique and comminuted

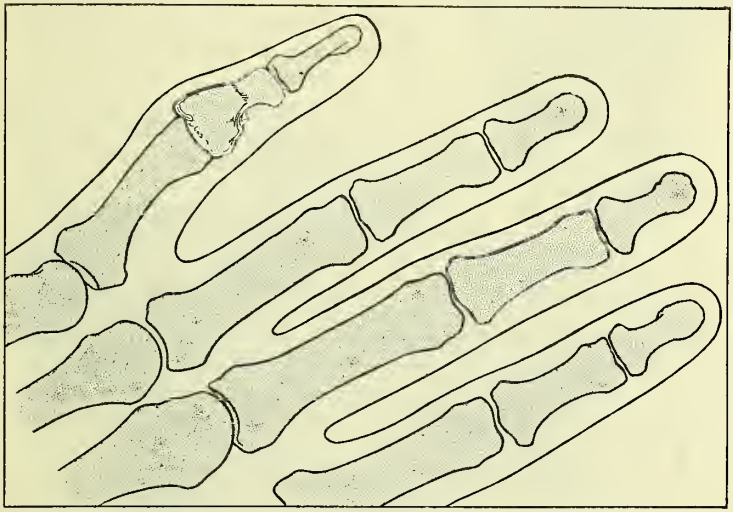


Fig. 159.—Tracing of Radiogram of Fracture of Second Phalanx of Little Finger. Phalanx united, showing thickening from callus formation.

fractures, union may take place with overlapping, producing a deformity which is sometimes troublesome by preventing the wearing of a glove or of rings. In compound fractures non-union sometimes occurs and causes persistent disability. In doubtful cases radioscopy renders valuable aid, as the parts are readily seen by the screen.

*Treatment.*—The contiguous fingers should be utilised as lateral splints, while a long palmar splint projecting beyond the fingers is employed to control the wrist-joint. Early movement and massage are necessary to prevent adhesions of tendons and consequent stiffness. In oblique and comminuted fractures, it

may be necessary to anæsthetise the patient to effect reduction; and in some cases extension applied in the same way as for fracture of a metacarpal is useful. When it is particularly desirable to avoid deformity an open operation may be advisable.



Fig. 160. — Backward Dislocation of Metacarpo-Phalangeal Joint of Thumb.

**Dislocations.**—*Dislocations of the metacarpo-phalangeal joint of the thumb.*—The commonest dislocation at this joint is a *backward* displacement of the proximal phalanx, which may be complete or incomplete. Its special clinical importance lies in the fact that much difficulty is often experienced in effecting reduction.

This dislocation is usually produced by extreme dorsiflexion of the thumb, whereby the palmar or glenoid and the lateral ligaments are torn from their metacarpal attachments, the phalanx carrying with it the glenoid ligament and sesamoid bones. The head of the metacarpal bone passes forward between the two heads of the flexor brevis pollicis, and the tendon of the long flexor slips to the ulnar side. The phalanx passes on to the dorsum of the metacarpal, where it is held erect by the tension of the abductor and adductor muscles.

The attitude of the thumb is characteristic (Fig. 160). The



Fig. 161.—Reduction of Dislocation of Thumb with aid of "Indian Puzzle."

metacarpal is adducted, its head forming a marked prominence on the front of the thenar eminence, and the phalanges are displaced backwards and more or less flexed upon one another.

Many explanations of the difficulty so often experienced in

reducing this variety of dislocation have been offered, but the consensus of opinion now seems to be that it is due to the interposition of the glenoid ligament and the sesamoid bones between the phalanx and the metacarpal, and that this is most frequently the result of ill-advised efforts at reduction. In some cases the tension of the long flexor tendon may be a factor in preventing reduction, but the "button-holing" by the short flexor is probably of no importance.

Reduction is to be effected by flexing and adducting the

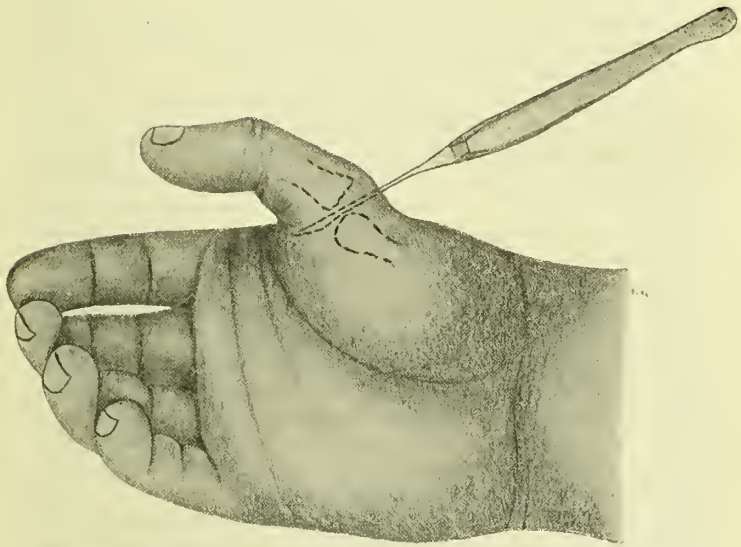


FIG. 162.—To illustrate Method of dividing the Glenoid Ligament by Subcutaneous Operation.

metacarpal while the phalanx is hyper-extended and pushed down towards the joint and levered over the head of the metacarpal.

When this manipulation fails, the glenoid ligament should be divided longitudinally through a puncture made with a tenotomy knife on the dorsal aspect of the joint, so as to separate the sesamoid bones and permit the passage of the head between them (Fig. 162). An open operation is seldom necessary.

Dislocation *forward* is rare. It results from forced flexion of the thumb with abduction, tearing the posterior and internal

lateral ligaments. The deformity is characteristic: the rounded head of the metacarpal projecting behind the level of the joint, while the base of the phalanx forms a prominence among the muscles of the thenar eminence.

Reduction is easily effected by making traction on the phalanges and carrying out movements of flexion and extension. The deformity, however, is liable to be reproduced unless a retentive apparatus is securely applied.

*Lateral* dislocations of the thumb are very rare.

Dislocation of the *metacarpo-phalangeal joint of the fingers* may be backward or forward. They are less common than those of the thumb, but present the same general characters. In the backward variety the same difficulty in reduction as is met with in the corresponding dislocation of the thumb sometimes occurs, and is to be dealt with on the same principles.

*Inter-phalangeal Dislocations.*—The middle and the ungual phalanges may be displaced backwards, forwards, or laterally. The clinical features are characteristic, and the diagnosis, as well as reduction, is easy. These dislocations are very frequently compound, and being difficult to render aseptic often necessitate amputation.

*Persistent flexion of the terminal phalanx* of the thumb or fingers (*drop or mallet finger*) may result from violence applied to the end of the digit when in the extended position—as, for example, in attempting to catch a cricket-ball. The terminal phalanx is flexed towards the palm, and the patient is unable to extend it voluntarily. This condition is of the nature of a sprain, and is usually ascribed to stretching or tearing of the insertion of the tendon of the long extensor.

The treatment consists in applying a short anterior splint secured by a few turns of adhesive plaster, to keep the joint extended until the extensor tendon heals.

Massage and movement should be employed daily after the first week. When the deformity persists in spite of this treatment the tendon may be stitched in position by an open operation (Tubby).

# CHAPTER XXV.

## INJURIES IN THE REGION OF THE PELVIS, HIP-JOINT, AND THIGH.

Fractures of Pelvis: *Varieties*—Injuries in Region of Hip: Surgical anatomy; *Fracture of head of femur; Fractures of neck of femur; Fracture below lesser trochanter*—Dislocations of Hip: *Varieties*—Sprains—Contusions—Fractures of Shaft of Femur.

### Fracture of the Pelvis.

For descriptive as well as for practical purposes it is useful to divide fractures of the pelvis into those which involve the integrity of the pelvic girdle as a whole, and those confined to individual bones.

In all, the prognosis depends upon the severity of the visceral lesions which so frequently complicate these injuries, rather than upon the fractures themselves.

**Fractures implicating the pelvic girdle as a whole** usually result from severe crushing forms of violence, such as the fall of a mass of coal or a pile of timber, or the passage of a heavy wheel over the pelvis. The force may act in the transverse axis of the pelvis, or in its antero-posterior axis. The pelvic viscera may be lacerated by the tearing asunder of the bones, or perforated by sharp fragments.

As a rule, more than one part of the pelvis is broken, the situation of the lesions and the clinical features varying in different cases.

*Separation of the pubic symphysis* may result from violence inflicted on the fork, as in coming down forcibly on the pommel of a saddle; from forcible abduction of the thighs; or it may happen during child-birth. In some cases there is no permanent displacement, the only evidence of the injury being localised pain in the region of the symphysis elicited on making pressure over any part of the pelvis. In others the two pubic bones overlap

one another, in which case the membranous portion of the urethra, or the bladder wall, is liable to be torn. The displaced bones may be palpated through the skin, or by vaginal or rectal examination.

The *pubic portion* of the pelvic ring is the most common seat of fracture. The bone gives way at its weakest points—namely, through the horizontal ramus of the pubes just in front of the pectineal eminence, and at the lower part of the descending ramus (Fig. 163). The intervening fragment of bone is isolated, and may be displaced. These fractures are frequently bilateral, and are often associated with separation of the sacro-iliac joint, with longitudinal fracture of the sacrum (Fig. 165), or with other fractures of the pelvic bones.



Fig. 163.—Fracture of Pelvis through Horizontal and Descending Rami of Pubes.

Injuries of the membranous urethra and bladder are frequent complications of these fractures (Vol. II.). Less commonly the rectum, the vagina, or the iliac blood-vessels are damaged.

Localised tenderness at the seat of fracture, pain referred to that point on pressing together or separating the iliac crests, and mobility of the fragments with crepitus, are usually present. The fragments may sometimes be felt on rectal or vaginal examination. As in all cases of pelvic fracture, shock is a prominent feature.

*The lateral and posterior aspects* of the pelvic ring may be implicated either in association with pubic fractures or independently. Thus a fracture of the iliac bone may run into the great sciatic notch; or a vertical fracture of the sacrum or separation of the sacro-iliac joint may break the continuity of the pelvic brim. In rare cases these injuries are accompanied by damage to the intestines, the rectum, the sacral nerves, or the iliac blood-vessels.

*Treatment.*—In all fractures of the pelvis it is of importance that the patient be moved and handled with the greatest possible care, lest fragments become displaced and injure the viscera.

He should be put to bed on a firm mattress. Some surgeons prefer a mattress made in three pieces, for convenience in using the bed-pan and for the prevention of bed-sores, but we have never found this to be of any service in practice.

Before the treatment of the fracture is commenced the surgeon must satisfy himself, by the use of the catheter and by other means, that the urethra and bladder are intact. Should these or any other of the pelvic viscera be damaged, these injuries must receive the first attention.

The treatment of the fracture itself consists in adjusting the fragments, as far as possible by manipulation, applying a firm binder or many-tailed bandage round the pelvis, and fixing the knees together by a bandage (Fig. 164).

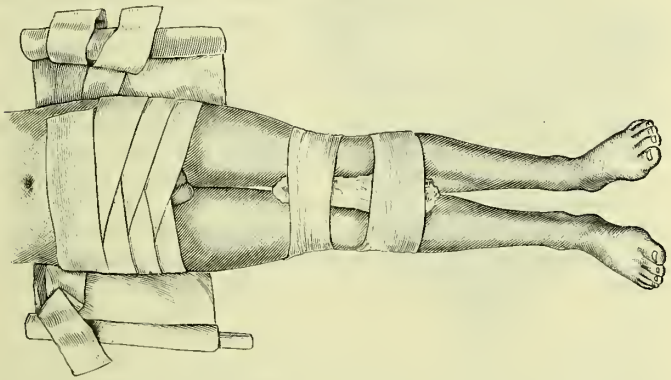


FIG. 164.—Many-tailed Bandage and Binder for Fracture of Pelvic Girdle.

In some cases extension may be applied to both legs, with the limbs abducted and fixed by sand-bags.

Compound fractures, being commonly associated with extravasation of urine, are liable to septic complications. Loose fragments should be removed, as they are prone to undergo necrosis.

The patient is confined to bed for six or eight weeks, and it may be several weeks more before he is able to resume active employment.

The *acetabulum* may be fractured by force transmitted through the femur, from a fall on the feet, the knees, or the great trochanter. It may merely be fissured, or the head of the femur may be forcibly driven through its floor into the pelvic cavity, either by fracturing the bone, or, in young

subjects, by bursting asunder the epiphysial junction of the constituent bones. When the femoral head penetrates into the pelvis, the condition simulates a fracture of the neck of the femur, but the trochanteric region is more depressed, and the displaced head may be recognised on rectal or vaginal examination. The limb is shortened, the movements of the joint much restricted and painful, but crepitus is not always to be detected.

When the head of the femur penetrates the acetabulum, reduction should be attempted by traction and manipulation. After reduction the limb is fixed in a long splint with extension as for fracture of the neck of the femur (Fig. 174). Reduction is often very difficult, and sometimes impossible.

In addition to the fracture of the floor of the acetabulum, it is necessary to mention a fracture of the upper and back part of the rim of this cavity which may accompany dorsal dislocation of the hip. Its clinical importance lies in the fact that crepitus may be present in addition to the symptoms of dislocation, and that after reduction the displacement is easily reproduced. This injury is liable to be mistaken for a fracture of the neck of the femur, but the flexion and internal rotation of the hip should prevent error. The treatment is the same as for fracture of the neck of the femur.

**Fractures of Individual Bones of the Pelvis.**—*Ilium.*—The expanded portion of the iliac bone is often broken by direct violence, the detached fragments varying greatly in size and position.

The whole or part of the *crest* may be separated by similar forms of violence.

When the fracture implicates the *ala* of the bone, it usually starts at the triangular prominence near the middle of the crest, and runs backwards or forwards, passing for a variable distance into the iliac fossa. The displaced fragment may sometimes be palpated and made to move when the muscles attached to it are relaxed. This is done by bending the body forward and towards the affected side and flexing the thighs. Pain and crepitus may be elicited on making this examination.

These fractures are treated by applying broad strips of adhesive plaster over the seat of fracture, and by placing the patient in such a position as will relax the muscles attached to the displaced fragment—in the case of the iliac spines by flexing the thigh upon the pelvis, and in the case of the crest or ala by raising the shoulders. Union takes place in three or four weeks.

In young persons the *anterior superior spine* has been torn

off and displaced downwards by powerful contraction of the sartorius muscle; and the *anterior inferior spine* by strong traction on the ⅄-shaped ligament. These injuries are best treated by fixing the displaced fragment in position by pegs or silver-wire sutures and relaxing the muscles acting on it.

Fracture of the *ischium* alone is rare. It results from a fall on the buttocks, the entire bone or only the tuberosity being broken. There is little or no displacement, and the diagnosis is made by external manipulation and by examination through the rectum or vagina.

A longitudinal fracture of the *sacrum* may implicate the posterior part of the pelvic ring, as has already been mentioned. In rare cases the lower half of the bone is broken *transversely* from a fall or blow, and the lower fragment is bent forward so that it projects into the pelvis and may press upon or tear the rectum, or the sacral nerves may be damaged, and partial paralysis of the lower limbs, bladder, or rectum result. These fractures are frequently comminuted and compound, and the soft parts may be so severely bruised and lacerated that sloughing follows. On rectal examination the lower segment of the bone can be felt, and on manipulating it pain and crepitus may be elicited.



FIG. 165.—Longitudinal Fracture of Sacrum from same Patient as Fig. 163.

Fracture of the *coccyx* may be due to a direct blow, or may occur during parturition. As a result of this injury the patient may have severe pain on sitting or walking, and during defecation. The loose fragment can usually be recognised on rectal examination. There is considerable difficulty in keeping the fragment in position, and if it projects towards the rectum it should be excised. If the lower fragment unites at an angle so as to cause pressure on the rectum, it gives rise to the symptoms of *coccydynia* and may call for excision.

## Injuries in the Region of the Hip.

These include the various fractures of the upper end of the femur; dislocations and sprains of the hip-joint; and contusions of the hip.

**Surgical Anatomy.**—The strength of the hip-joint depends primarily on its osseous elements—the rounded head of the femur filling the deep socket of the acetabulum, to the bottom of which it is attached through the medium of the ligamentum teres. The edge of the acetabulum is specially strong above and behind, while there is a gap in its lower margin, bridged over by the cotyloid ligament.

In relation to fractures of the upper end of the femur, it is to be borne in mind that as the antero-posterior diameter of the neck is less than that of the shaft, and as a considerable portion of the great trochanter lies behind the junction of the neck with the shaft, the greater part of any strain put upon the upper end of the femur is borne by the neck of the bone and not by the trochanter. The head and neck of the femur are nourished chiefly by the thick, vascular periosteum, and through certain strong fibrous bands reflected from the attachment of the capsule—the cervical ligaments of Stanley. The integrity of these ligaments plays an important part in determining union in fractures of the neck of the femur, both by keeping the fragments in position, and by maintaining the blood-supply to the short fragment. Whether it be true or not that an alteration in the angle of the femoral neck takes place with advancing years, it is generally recognised that this change is of no importance in relation to fractures in this region.

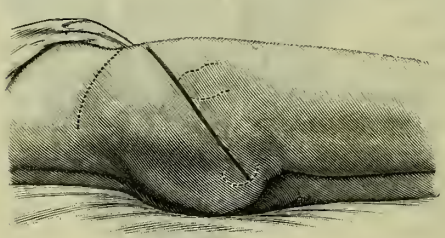


Fig. 166.—Nélaton's Line.

The capsular ligament of the hip is of exceptional strength. It is attached above to the entire circumference of the acetabulum, and below to the neck of the femur in such a way that while the whole of the anterior and inferior aspects of the neck lie within its attachment, only the inner half of the posterior and superior aspects is intra-capsular. The capsule is augmented by several accessory bands, the most important of which is the *ilio-femoral* or *Λ-shaped ligament* of Bigelow, which passes from the anterior inferior iliac spine to the anterior inter-trochanteric line, its fasciculi being specially thick towards the upper and lower ends of this ridge. The inner limb of this ligament limits extension of the thigh, while the outer limits eversion and adduction. The weakest part of the capsular ligament lies opposite the lower and back part of the joint.

The hip-joint is surrounded by muscles which contribute to its strength, the most important from the surgical point of view being the obturator internus, which plays an important part in certain dislocations, and the ilio-psoas, which influences the deformity in various lesions in this region.

Except in very thin subjects, the constituent elements of the hip-joint cannot be palpated through the skin. A line drawn vertically downwards from the middle of Poupart's ligament passes over the centre of the joint, which, in adults, lies on the same level as the tip of the great trochanter. In children it is somewhat higher.

For purposes of clinical diagnosis it is necessary to locate certain bony prominences, the most important being:—(1) The *anterior superior iliac spine*, which is most readily recognised by running the fingers along Poupart's ligament from within outwards. (2) The *ischial tuberosity*, which in the extended position of the limb is overlapped by the lower margin of the gluteus maximus muscle, and is therefore not easily located with precision. By flexing the limb and making pressure from below upwards in the gluteal fold the smooth, rounded prominence can usually be detected. (3) The quadrilateral *great trochanter* is readily recognised on the outer aspect of the hip. Its highest point or *tip* can best be felt by pressing over the gluteal muscles from above downwards.

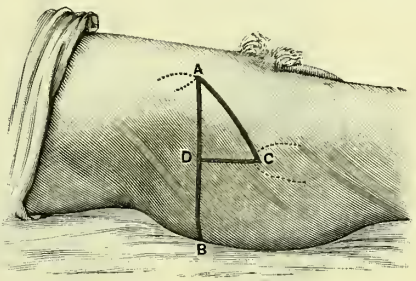



Fig. 167.—Bryant's Lines.

*Clinical Tests.* — If a line is drawn from the anterior superior iliac spine to the most prominent part of the ischial tuberosity, it just touches the tip of the great trochanter. This is known as *Nélaton's line* (Fig. 166).

*Bryant's test* (Fig. 167) is applied with the patient lying on his back, and consists in dropping a perpendicular AB from the anterior superior iliac spine, and drawing a line CD from the tip of the great trochanter to intersect the perpendicular at right angles. This is done on both sides of the body, and the length of the lines CD compared. Shortening on one side indicates an upward displacement of the trochanter, lengthening a downward displacement. The third side AC of the triangle indicates the distance between the anterior spine and the tip of the trochanter.

*Chiene's test*, which is simpler than either of these, consists in applying a strip of lead or tape across the front of the body at the level of the anterior superior iliac spines, and another touching the tips of the two trochanters. Any want of parallelism in these lines indicates a change in the position of one or other trochanter.

## Fractures of the Upper End of the Femur.

It will be convenient here to study the various fractures of the upper end of the femur which are liable to be confused with one another and with dislocations of the hip. These include fractures of the head, the neck, the trochanters, and separation of the upper epiphyses, and fracture of the shaft just below the trochanters.

Fracture of the **head of the femur** is exceedingly rare, and is usually a complication of backward dislocation of the hip. It takes the form of a split of the articular surface caused by impact against the edge of the acetabulum, and is analogous to

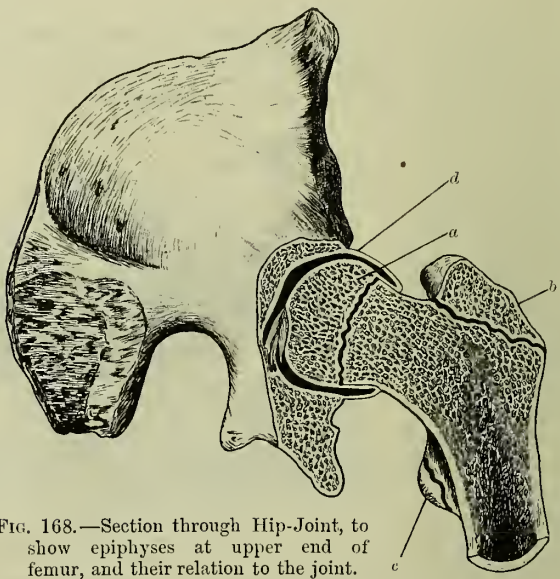



FIG. 168.—Section through Hip-Joint, to show epiphyses at upper end of femur, and their relation to the joint.

*a*, Epiphysis of head. *b*, Epiphysis of great trochanter. *c*, Epiphysis of lesser trochanter. *d*, Capsular ligament.

(After Poland.)

the indentation fracture of the head of the humerus, which may accompany dislocation of the shoulder.

In young subjects the **epiphysis of the head**, which lies entirely within the capsule of the joint (Fig. 168), is occasionally separated, and the symptoms simulate closely those of fracture of the narrow part of the neck of the femur.

### FRACTURES OF THE NECK.

It has long been customary to divide fractures of the neck of the femur into two groups—"intra-" and "extra-capsular"; but as in a considerable proportion of cases the line of fracture falls partly within and partly without the capsule, this

classification is wanting in accuracy. It is more correct to divide these fractures into (1) those occurring *through the narrow part of the neck*, which are nearly always purely intracapsular; and (2) those occurring *through the base of the neck*, in which the line of fracture lies inside the capsule in front, but outside of it behind.

It is of considerable clinical importance to distinguish between fractures in these two positions. The first group occurs almost exclusively in old persons as a result of slight forms of indirect violence, and it is liable, on account of the feeble vascular supply to the upper fragment, to be followed by absorption of the neck, which delays or may even entirely prevent union (Figs. 169 and 172). The second group usually occurs in robust adults, and results from severe forms of violence applied directly to the trochanter. In this group firm osseous union usually takes place.

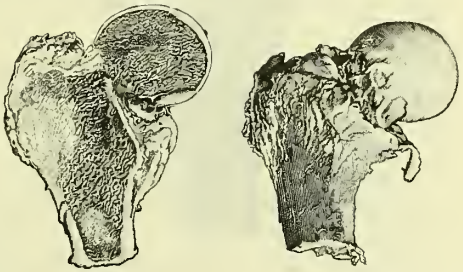


Fig. 169.—Fracture through Narrow Part of Neck of Femur. On surface view and on section. The neck of the bone has undergone absorption.

**Fracture of the Narrow Part of the Neck or Intracapsular Fracture.**—It was formerly believed that this fracture was exceedingly rare *in children*, but by the use of the X-rays and from the study of the condition known as coxa vara, it has been shown that it occurs with considerable frequency. In children, the fracture is of the greenstick variety, and the patient is often able to use the limb within a few days of the injury.

Fracture of the narrow part of the neck, however, is most frequently met with in elderly persons, especially in women, and is usually produced by comparatively slight forms of indirect violence—such, for example, as result from the foot catching on the edge of a carpet, a stumble in walking, or missing a step in going down stairs.

The line of fracture, which is usually transverse but may be oblique or irregular, lies, as a rule, entirely within the capsule and the posterior part of the neck is more comminuted than the anterior. The outer fragment, which includes the base of the neck, the trochanters, and the shaft, is usually displaced upward and

rotated outward. If the periosteum and the cervical ligaments



Fig. 170.—Impacted Fracture through Narrow Part of Neck of Femur.

remain intact, displacement is prevented and union favoured.

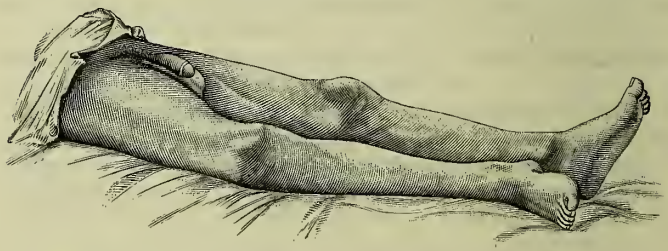


Fig. 171.—Fracture of Neck of Right Femur, showing shortening, abduction, eversion, and flexion of limb.

Impaction is less common than in fracture through the base of the neck, and it usually results from the patient falling on the

trochanter, the outer fragment being driven as a wedge into the inner (Fig. 170).

*Clinical Features.*—In non-impacted cases the limb is at once rendered useless, and the patient lies helpless. There is pain and tenderness in the region of the hip on making the slightest movement; and a specially tender spot may be localised, indicating the seat of fracture.

On placing the pelvis as square as possible, and comparing the measurements of the limbs from the anterior superior spine to the external malleolus, shortening of the injured limb to the extent of from one to three inches may be found. On applying Nélaton's, Bryant's, or Chiene's tests, the tip of the great trochanter will be found elevated. It is also further back and less prominent than normal.

The whole limb is usually everted to a greater or less degree, and is slightly abducted. On comparing the ilio-tibial band of the fascia lata on the two sides, it is found to be relaxed on the injured side.

The violence being as a rule indirect, there is at first little or no discoloration in the vicinity of the hip, but this may appear a few days later.

Crepitus is not a constant sign, and should not be diligently sought for, as the necessary manipulations are liable to disengage the fragments and to increase the deformity. For the same reason rotatory movements are to be avoided. It is often stated that when the neck of the femur is broken the trochanter may be recognised to rotate through the arc of a smaller circle than under normal conditions. Theoretically this may be true, but the difference is so slight as to render the sign of little clinical value.

The symptoms are so variable, and often so slight, that it may be exceedingly difficult, if not impossible, to make a positive diagnosis immediately after the accident. In all cases of uncertainty the patient should be put to bed, and treated as for a fracture. In the course of a few days, when the swelling has subsided and the pain abated, a further examination should be made, and the subsequent treatment determined by the result.

In examining an old person who has sustained an injury in the region of the hip, it should be borne in mind that the limb may be shortened and everted as a result of arthritis deformans, and that the symptoms of that disease may simulate those of fracture. In arthritis deformans, however, the ilio-tibial band of the fascia lata is not relaxed as it is in fracture.

In some cases, and particularly in those in which the

periosteum of the neck and the cervical ligaments remain intact, the shortening does not become apparent till a few days after the accident. As the other symptoms are correspondingly obscure, the condition is apt to be mistaken for a bruise. In all doubtful cases the part should be examined from day to day, and, if possible, the X-rays should be used. In *impacted* cases the signs of fracture are often obscure, and the patient may even be able to walk after the accident. The skin over the trochanter is usually discoloured from bruising. Eversion is usually present, but shortening may be very slight. Crepitus is absent. In old people it is seldom advisable to undo impaction, as the interlocking of the bones favours the occurrence of osseous union.

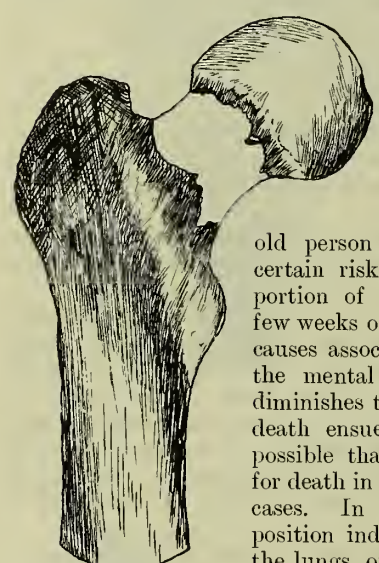


Fig. 172. — Fracture of Narrow Part of Neck of Femur. The neck has become absorbed.

*Prognosis.*—A fracture of the neck of the femur in an old person is always attended with a certain risk to life, a considerable proportion of the patients dying within a few weeks or months of the accident from causes associated with it. In some cases the mental and physical shock so far diminishes the vitality of the patient that death ensues within a few days. It is possible that fat embolism may account for death in some of the more rapidly fatal cases. In others, the continued dorsal position induces hypostatic congestion of the lungs, or, owing to the difficulties of nursing, bed-sores may form and death result from septic absorption. Frequently the prolonged confinement to bed, the continuous pain, and the natural impairment of appetite wear out the patient's strength. In many cases the patient becomes peevish, irritable, or mentally weak.

Osseous union is the exception in intra-capsular fracture, especially when the periosteum and the cervical ligaments have been completely torn. In sub-periosteal and in impacted fractures it sometimes occurs. As a rule, however, the neck of the femur becomes absorbed and disappears, the head of the bone comes to lie in contact with the base of the trochanter, and a false joint

forms (Figs. 169 and 172). Chronic changes of the nature of arthritis deformans may occur in and around such false joints.

When osseous union fails to take place, although the patient may eventually be able to get about, he can do so only with the aid of a stick or crutch. As the limb is unable to bear the weight of the body, and as there is marked shortening, the patient walks with a decided limp. There is considerable antero-posterior thickening of the neck of the femur, and the femoral vessels may be pushed forward in Scarpa's triangle. On handling the part the femur may be made to move up and down on the ilium, and there is creaking similar to that met with in arthritis deformans.

*Treatment.*—In treating a fracture through the narrow part

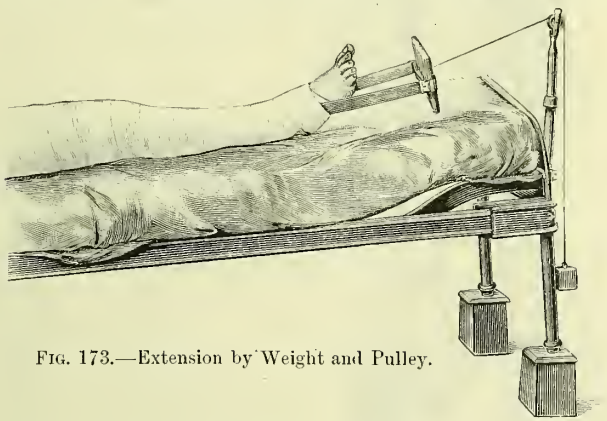


Fig. 173.—Extension by Weight and Pulley.

of the neck, it is necessary to consider the age and general condition of the patient; whether the fracture is impacted or not; and the site of the fracture—whether in the narrow part of the neck or at its base. "The first indication is to save life, the second to get union, and the third to correct or diminish displacements" (Stimson).

In old and debilitated patients, prolonged confinement to bed in the dorsal attitude is liable to endanger life by favouring hypostatic congestion of the lungs and the formation of bed-sores. Bony or even firm fibrous union seldom takes place in these patients, especially when the fracture is through the narrow part of the neck; and it is generally advisable to get them out of bed as speedily as possible. For the first few days the patient may be kept on his back, the limb being steadied by

sand-bags ; but on the first sign of respiratory or cardiac trouble he should be propped up in bed, and as soon as possible lifted into a chair. In all such cases care should be taken to avoid undoing impaction.

When the general condition of the patient permits of it, an attempt should be made to secure bony union by immobilisation in bed, by one or other of the following appliances.

Shortening may be counteracted by *extension with weight and pulley* (Fig. 173). Strips of strong adhesive plaster are applied to each side of the limb, reaching well above the middle of the thigh. To the lower ends of these are attached broad tapes, to which a stirrup is buckled, and through it traction is made by means of a cord passing over a pulley, the weight varying with the requirements of the case. In a moderately muscular adult, a weight of from six to eight pounds should be applied at first, and increased or diminished as required. The correct weight to employ is that which maintains the length of the limb at its normal. In some cases it may be necessary to use as much as fifteen or twenty pounds. The necessary counter-extension is obtained by raising the foot of the bed on blocks.

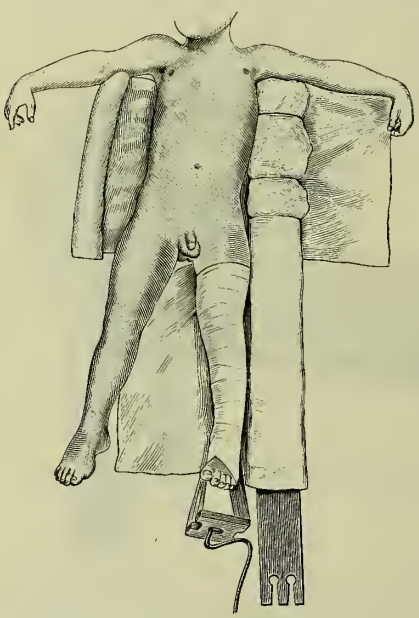


FIG. 174.—Long Splint with Extension Plasters applied for Fracture of Neck of Femur.

When it is considered necessary to control the joints above and below the fracture, this may be done by means of *Liston's long splint* (Fig. 174), which extends from the axilla to two or three inches beyond the foot. The part of the splint which lies in contact with the lower extremity is enclosed in a sheet which envelops the limb, while the upper part is fixed to the thorax by means of a broad roller bandage. Rotation of the

limb is prevented by fixing the lower end of the splint in a foot-rest. In restless patients it is an advantage to apply a long splint to the sound leg in addition, and to connect the two splints by a cross-bar below.

Eversion may be corrected by sand-bags placed alongside the limb, or by means of a piece of wood fixed to the back of the knee at right angles to the axis of the limb by a few turns of plaster-of-Paris bandage. It is important also to keep the bed-clothes clear of the foot by means of a cage.

The retentive apparatus is worn for about six weeks, after which the patient is allowed to move about with the aid of crutches.

In exceptional cases, recourse may be had to accurate fixation of the fragments to one another by means of a long steel peg introduced through the skin over the great trochanter, and passed so as to transfix the two fragments; or the fragments may be exposed by an open operation and sutured together with silver wire, the torn capsule being stitched with catgut.

*Hodgen's splint* (Fig. 180) is one of the most comfortable and efficient means of treating these fractures, as it allows the patient a certain amount of movement, and facilitates nursing.

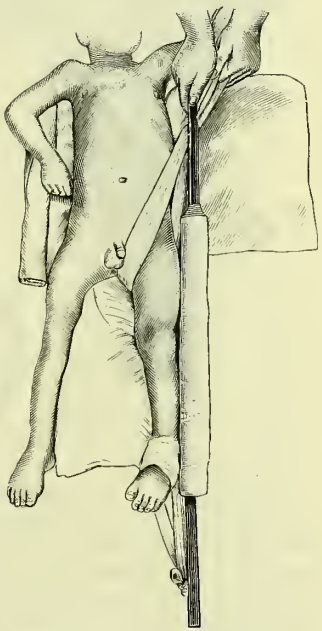


Fig. 175.—Long Splint with Perineal Band.

As a temporary means of securing the limb—for example, while the patient is being transported to hospital—extension may be obtained by means of a *perineal band* attached to *Liston's long splint* (Fig. 175). The patient's foot, carefully padded, is fixed to the lower end of the splint by means of a bandage or triangular handkerchief. By pushing the splint down traction is made upon the limb, and this is maintained by means of a padded triangular bandage passed through the perineum and fixed to the upper end of the splint. This method is less efficient and more uncomfortable than that by weight and pulley.

**Fracture through the Base of the Neck.**—This fracture is usually produced by a fall on the great trochanter, although it is occasionally due to a fall on the feet or knees.

Although often spoken of as "extra-capsular," on account of the disposition of the capsular ligament already described, the line of fracture is generally partly within and partly without the capsule. The fracture usually lies close to the junction of the neck with the shaft, and in the great majority of cases is accompanied by breaking of one or both trochanters. This is due to the inner fragment being driven as a wedge into the outer, splitting up the trochanters. When the fragments remain interlocked, the fracture is of the *impacted* varicty (Fig. 176); otherwise it is spoken of as *non-impacted.*

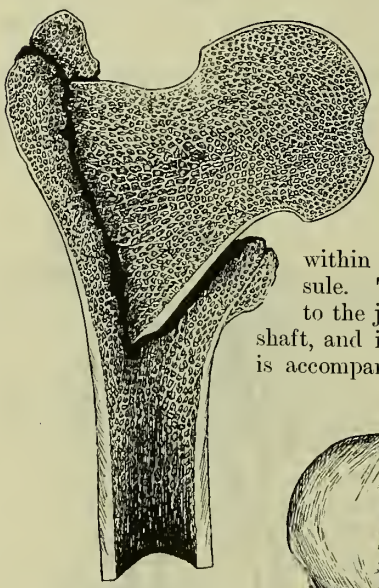


FIG. 176.—Fracture through Base of Neck of Femur with Impaction into the Trochanters.

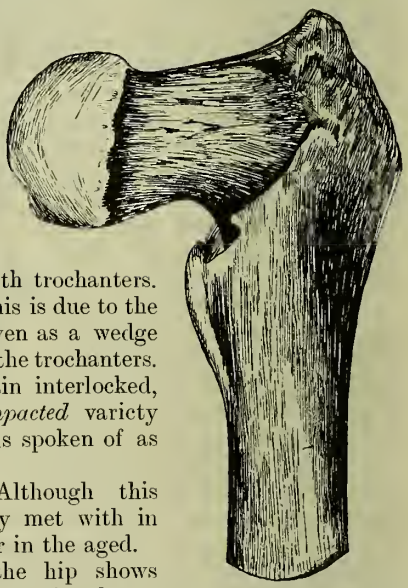


FIG. 177.—Non-Impacted Fracture through Base of Neck of Femur with diminution of angle of neck.

*Clinical Features.*—Although this fracture is most commonly met with in strong adults, it may occur in the aged.

The outer aspect of the hip shows marks of bruising, and there is always severe pain and a considerable degree of shock. There is generally marked eversion of the limb, with shortening, which, in most cases, is evident immediately after the accident, and is due to the lower fragment being drawn up

by the muscles inserted into the great trochanter and upper end of the shaft.

On applying the various tests the great trochanter is found displaced upwards, and there is a marked antero-posterior broadening of the trochanteric region, especially in the impacted variety, and the ilio-tibial band is relaxed. On pressing the fingers into the outer part of Scarpa's triangle, a bony mass consisting of the broken fragments may be felt, and is tender on pressure.

In non-impacted cases unnatural mobility with crepitus may be elicited. Impaction, by masking the symptoms, adds to the difficulty of diagnosis, but not to the same extent as in fracture of the narrow part of the neck.

*Prognosis.*—The risks to life in the aged are similar to those of intra-capsular fracture. In youths and healthy adults the chief danger is that the limb may be shortened and its function thereby impaired. In children it may be followed by coxa vara.

As the periosteum and cervical ligaments which transmit the blood-vessels to the short fragment are intact, bony union is the rule. There is always, however, considerable thickening in the region of the trochanter due to displaced fragments and callus, and in a certain number of cases, even with the greatest care in treatment, there is a varying degree of shortening and eversion of the limb. In cases where the outer fragment lies in front of the inner there is permanent inversion.

*Treatment.*—As this fracture usually occurs in robust patients, there is no danger from prolonged immobilisation in bed; and as union without deformity can be attained in no other way this is always advisable. When the shortening and eversion are excessive, they should be completely corrected under anæsthesia before the retentive apparatus is applied, any impaction which exists being undone. When the deformity resulting from impaction is slight, however, it is best to leave it, as it facilitates speedy and firm union.

The same retentive appliances are used as in fracture through the narrow part of the neck (p. 524).

Fracture of the **great trochanter** occurring apart from fracture of the neck results from direct violence. The trochanter is displaced by the gluteal muscles, causing broadening of the outer aspect of the hip. In young persons the epiphysis of the great trochanter may be separated, but this is very rare. The treatment consists in fixing the fragments in position by strips of adhesive plaster, or by pegs driven in through the skin.

**Fracture immediately below the lesser trochanter** may be

produced by direct or by indirect violence, and the displacement depends largely on whether the line of fracture is transverse or oblique. The upper fragment is tilted forward and rotated outward by the ilio-psoas muscle and the external rotators inserted in the region of the great trochanter. The lower fragment is pulled upward and rotated outward by the flexors and adductors, the weight of the limb aggravating the eversion. The tilting of the upper fragment may be increased by the displaced lower fragment pushing it forward.

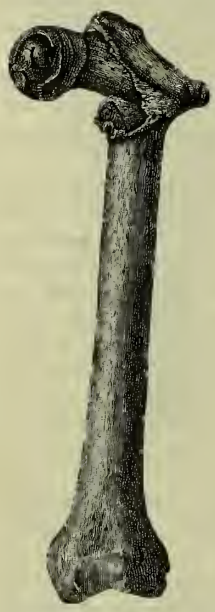


Fig. 178.—Fracture of Femur just below the Small Trochanter united, showing flexion and external rotation of upper fragment.

On account of the difficulty of controlling the short upper fragment, union is liable to take place with considerable shortening and deformity (Fig. 178).

*Treatment.*—When it is found, under chloroform, that the displacement can be completely reduced, and the fragments kept in accurate apposition by carefully padded local splints, this fracture is treated on the same lines as fractures of the shaft of the bone.

In cases in which the upper fragment cannot be brought into line with the lower one, however, it is necessary to flex and slightly rotate outward and abduct the thigh in order to get the fragments into apposition. This is most simply done by means of a double-inclined plane (Fig. 179), while at the same time extension may be applied in the axis of the thigh.

Hodgen's splint (Fig. 180) fulfils these indications, and it has the advantage of permitting of the patient being moved or even propped up in bed without fear of disturbing the fracture. It consists of a wire frame to one side of which a series of strips of flannel about four inches wide are attached. The frame, which extends from the level of Poupart's ligament to well beyond the sole, is placed over the front of the limb, and the loose ends of the flannel strips, brought round behind the limb, and fixed to the other side of the frame, convert it into a sling. The strips of flannel may be replaced with advantage by a strong, wide-meshed net. Extension strapping is applied to

the limb in the usual way, and is attached to the lower end of

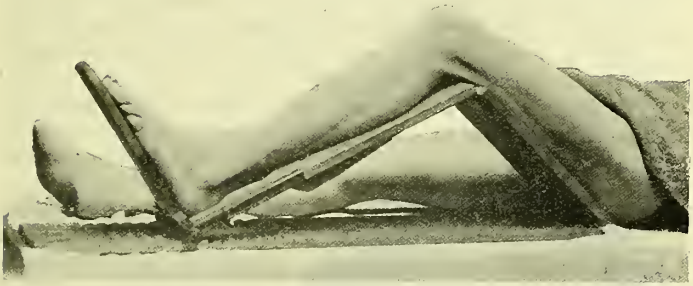


FIG. 179.—Adjustable Double-inclined Plane.

the frame. By suspending the limb in this splint by means of cords passing obliquely over a pulley attached to an upright at the foot of the bed, the weight of the limb is made to act as the extending force. It should be kept on for six or eight weeks, after which a plaster-of-Paris spica is applied, and the patient allowed to walk on crutches for three or four weeks longer.

### DISLOCATIONS OF THE HIP.

It is unnecessary for our present purpose to attempt a comprehensive classification of the numerous varieties of dislocation

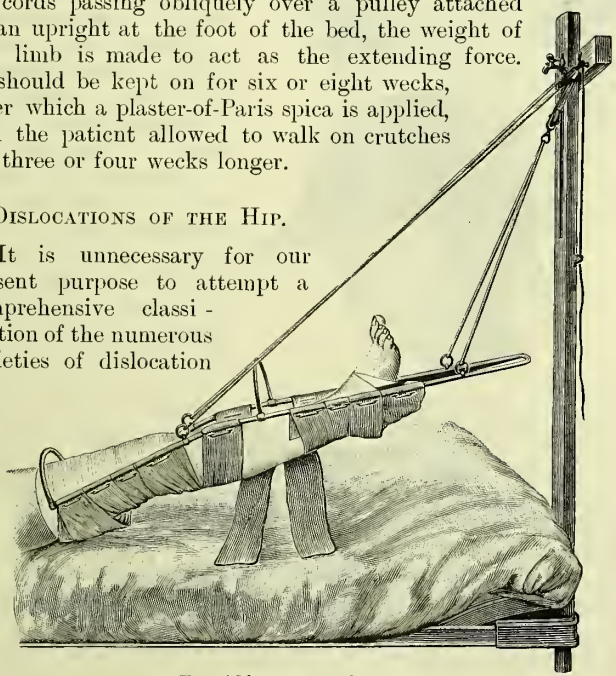


FIG. 180.—Hodgen's Splint.

which have been met with at the hip-joint.

It will suffice if we divide them into those in which the head of the femur passes backward, and comes to rest on the dorsum ilii, or in the vicinity of the ischiatic notch; and those in which it passes forward and comes to rest in the obturator foramen, or on the pubes (Fig. 181).

The backward are much more common than the forward dislocations, in contrast to what obtains at the shoulder, where the forward varieties predominate.

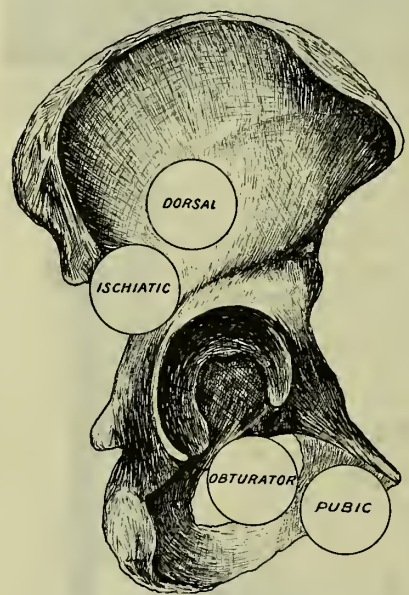



FIG. 181.—Diagram of the most common Dislocations of the Hip.

On account of the great strength of the hip-joint, dislocation is by no means a common injury. It occurs most frequently in strong adults after the epiphyses have ossified, and before the bones have commenced to become brittle; and it is much more common in men than in women. It is invariably the result of severe violence, the limb at the moment being in such a position that the ligaments are on the stretch and the muscles taken at a disadvantage. The head of the femur usually leaves the joint at the lower and back part, where the socket is shallowest and the ligaments weakest. The ligamentum teres is almost always torn from its femoral attachment, and one or more of the muscles inserted in the region of the trochanters may be ruptured. The ⅄-shaped ligament, on the other hand, is seldom torn, and so long as it remains intact the dislocation belongs to one or other of the types above named. All atypical dislocations, such as the supra-cotyloid, infra-cotyloid, ilio-pectineal, are due to rupture of some part of the ⅄-ligament, and are so rare as not to call for individual description.

Like other dislocations, those of the hip may be complicated by laceration of muscles, blood-vessels, or nerves, or by fracture of one or other of the bones in the vicinity.

**Dislocation on to the Dorsum Ilii.**—This, the commonest form of dislocation of the hip, is usually the result of the patient falling from a height, or receiving a heavy weight on the back while stooping forward with the thigh flexed, slightly adducted, and rotated in. It is also said to have occurred from muscular action. The shaft of the femur acts as the long limb of a lever of which the neck is the short limb, while the femoral attachment of the ʎ-ligament forms the fulcrum. The head, thus brought to bear upon the lower and back part of the capsule, tears it and leaves the socket, passing upwards and coming to rest on the back of the ilium, above and anterior to the tendon of the obturator internus (Fig. 182). The articular surface is directed backward, while the trochanter looks forward.

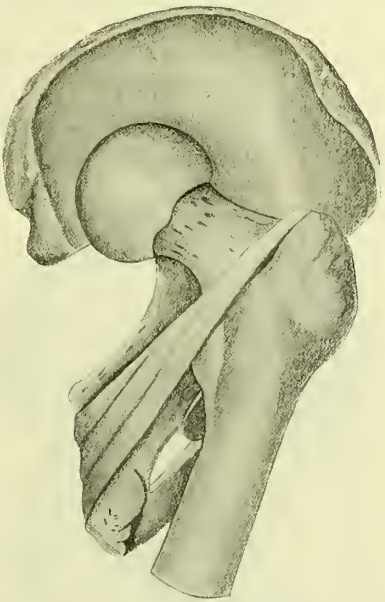


Fig. 182.—Dislocation on to Dorsum Ilii. Note relation of neck of femur to tendons of obturator internus and gemelli.

*Clinical Features.*—The affected limb is flexed, adducted, and rotated inward, so that the knee crosses the lower third of the opposite thigh, and the ball of the great toe lies on the dorsum of the sound foot (Fig. 183). There is shortening to the extent of from one and a half to two inches, the trochanter being displaced above Nélaton's line, and lying nearer to the anterior superior iliac spine than on the normal side. The patient is unable to move the limb or to bear weight upon it; abduction and external rotation are specially painful; and traction fails to restore the limb to its proper length. On making these attempts a characteristic elastic resistance is felt.

The head of the femur in its new position may sometimes be felt through the fibres of the gluteus maximus, but swelling of the soft parts often obscures this sign. The normal depression behind the great trochanter is lost, the gluteal fold

is raised, and there is often a degree of lordosis which compensates



FIG. 183.—Dislocation of Femur on to Dorsum Ilii, showing flexion, adduction, and shortening of the limb.

for the flexion. The fingers can be pressed more deeply into Scarpa's triangle on the dislocated than on the normal side—a point in which this injury differs from fracture of the base of the neck of the femur.

In a certain number of cases the outer limb of the ⅄-ligament is ruptured and the limb is everted — *dorsal dislocation with eversion*; but in other respects the clinical features are much the same.

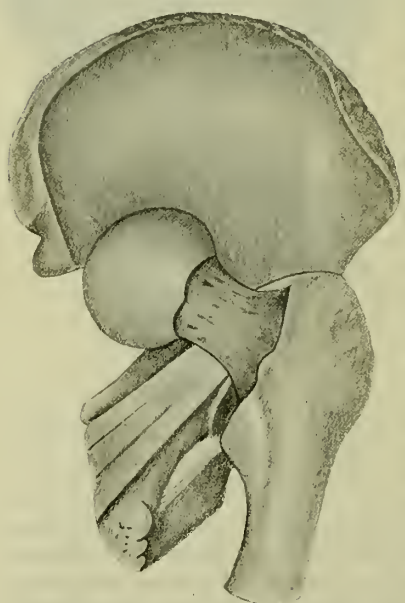


FIG. 184.—Dislocation into the vicinity of the Ischiatic Notch. Note relation of neck of femur to tendons of obturator and gemelli, "Dislocation below the tendon."

**Dislocation into the vicinity of the Ischiatic Notch**, or "*dislocation below the tendon.*"—This variety of backward dislocation is less common than that on to the dorsum, although produced in the same way. The head of the femur passes beneath the obturator internus, and this tendon, catching on its neck, checks its upward movement (Fig. 184).

The *clinical features* are the same as those of the dorsal variety, but, on the whole, are less marked.

*Differential Diagnosis.*—Backward dislocations of the hip are usually easily recognised. When dislocation below the tendon occurs in a very stout person, however, it is liable to be overlooked on account of the difficulty of feeling the displaced bone, and of the comparatively slight amount of deformity present. The nature of the accident, the absence of broadening of the trochanter, and the adduction and inversion of the limb are usually sufficient to prevent a dislocation being mistaken for an impacted extra-capsular fracture.

**Dislocation into the Obturator Foramen** (Fig. 181).—This dislocation is produced by great force applied from behind while the thigh is flexed and abducted, as when a weight falls on the back of a man stooping forward with the legs wide apart. It may also result from violent abduction by wide separation of the thighs.

The capsule gives way at its inner and lower part, and the head of the femur comes to rest on the surface of the external obturator muscle, its articular surface looking forward, while the trochanter looks backward.

*Clinical Features.*—The thigh is slightly flexed and abducted, with the foot pointing directly forward or a little outward. The body is bent forward to relax the ilio-psoas muscle and the Y-ligament, the foot is advanced and the heel drawn up. It is not uncommon for the patient to be able to walk after the accident, and only to seek advice some time after on account of inability to adduct and extend the limb. There is apparent lengthening of the limb due to tilting of the pelvis downward on the affected side. The hip is flattened, the trochanter less prominent than usual, and the head of the bone may sometimes be felt in its abnormal position. It is doubtful if a rectal examination gives reliable information as to the position of the head of the femur.

**Dislocation on to the pubes** is a further degree of the obturator form (Fig. 181). It is usually produced by forcible hyper-extension and external rotation of the hip, such as occurs when the body is bent back while the thigh remains fixed.

The capsule is torn further forward than in the other varieties, and the head rests on the horizontal ramus of the pubes against the ilio-pectineal line.

*Clinical Features.*—There is marked eversion, flexion, and abduction, but the shortening is inconsiderable. The ilio-psoas and Y-ligament are tense. The head of the femur may be felt in the groin, with the femoral vessels over, or to one or other side of it. There is sometimes pain and numbness in the

distribution of the anterior crural nerve. The prominence of the great trochanter is lost.

**Treatment of Dislocations of the Hip.**—For the reduction of a dislocation of the hip complete anæsthesia is necessary, and the patient should be placed on a firm mattress on the floor, to give the surgeon the best possible purchase upon the limb. The surgeon grasps the ankle with one hand, while the other is placed behind the head of the tibia, the leg being held at right angles to the thigh. An assistant meantime steadies the pelvis by making firm pressure over the iliac crests.

As the chief obstacle to reduction is the tension of the ilio-femoral ligament, the first indication is to relax this structure by flexing the hip.

In the *backward* varieties (dorsal and ischiatic) the ⅄-ligament is relaxed by flexing the thigh upon the pelvis in the position of adduction. The thigh is then fully abducted, to cause the head of the bone to retrace its steps forwards towards the rent in the capsule; and at the same time rotated outwards, to relax the rotator muscles. This combined movement tends also to open up the rent in the capsule. Finally, the limb is quickly extended to cause the head to enter the socket. This object is often aided by making vertical traction or lifting movements on the abducted and externally rotated limb before extending.

For the reduction of the *forward* varieties (obturator and pubic), the thigh is first fully flexed on the pelvis, but in the abducted position. The limb is then strongly rotated inward and adducted, and finally extended. Lifting movements may be found useful in these cases also.

All methods of reduction by forcible traction on the extended limb are to be avoided, as they fail to meet the primary indication of relaxing the ⅄-ligament.

After reduction the limb is steadied by sand-bags; massage is carried out from the first, and movement after a few days. The range of movement is gradually increased, and the patient is allowed to use the limb with caution in from two to three weeks.

When the rim of the acetabulum has been fractured, the patient must be confined to bed with extension and a long splint for eight or nine weeks, to avoid the risk of redislocation.

Changes of the nature of chronic arthritis are liable to occur in and around the joint in old and rheumatic subjects; and atrophy or paralysis of muscles may follow, if their nerves are injured.

**Old-Standing Dislocations.**—It is impossible to lay down

any time-limit for attempting reduction in old-standing dislocations of the hip. Manipulation may succeed in cases of some months' standing, and may fail when the bone has only been out a few weeks. In certain cases, even after reduction has been effected, there is a marked tendency to redisplacement. In any case, the attempt does good by breaking down adhesions, provided no undue force is employed such as may damage the sciatic nerve or vessels, or fracture the neck of the femur. If manipulation fails, and if the deformity is great and the usefulness of the limb seriously impaired, an attempt may be made to effect reduction by operation, the head of the bone being excised if necessary; but if the head has formed a new socket for itself and there is a fairly useful joint, the condition should be left alone.

*Congenital Dislocations of the Hip* are described with deformities.

**Sprains** of the hip are comparatively rare. They result from milder degrees of the same forms of violence as produce dislocation. The ligaments are stretched or partially torn, and there is effusion of fluid into the joint. Pressure over the joint elicits tenderness; and the limb assumes the position of slight flexion, abduction and external rotation, but there is no alteration in the length of the limb. Such injuries, unless carefully treated, are apt to be followed by the formation of adhesions resulting in stiffness of the joint.

**Contusions** in this region, on the other hand, are not uncommon. They are produced by a fall on the trochanter such as may cause fracture of the neck of the femur, and they give rise to symptoms which simulate to some extent those of fracture. The limb lies in the position of slight flexion, but the bony points retain their normal relationship to one another, and there is no actual shortening. The swelling and tenderness often prevent a thorough examination being made, and when any doubt remains as to the diagnosis, the patient should be kept in bed till the doubt is cleared up. If a fracture has occurred it will reveal itself in the course of a few days by the occurrence of shortening and other evidences of fracture.

In elderly patients, contusions of the hip may be followed by changes in the joint of the nature of arthritis deformans; and it has been stated, although proof is wanting, that absorption of the neck of the femur sometimes occurs. These injuries are treated by rest in bed, massage, and the other measures already described as applicable to sprains and contusions.

### Fractures of the Shaft of the Femur.

This group includes all fractures between that immediately below the trochanter minor and the supra-condylar fracture. These fractures are even more common in children than in adults. In adults, when the fracture is due to direct violence, it is usually transverse, and may be attended with comparatively little displacement. Indirect violence, on the other hand, usually produces complete and oblique fractures, which are frequently comminuted and often compound. The break is most commonly situated a little above the middle of the shaft, the obliquity being downward, forward, and inward, and of such a nature that the fragments tend to override one another (Fig. 185).

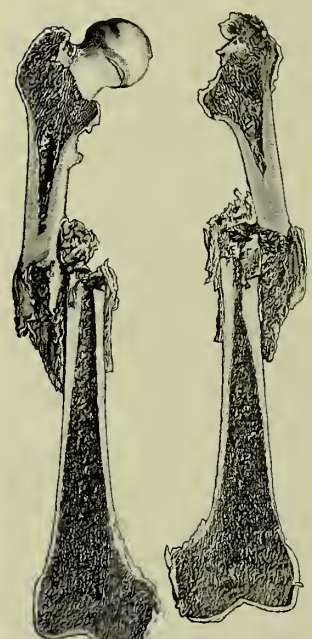


Fig. 185.—Longitudinal section of Femur showing Recent Fracture of Shaft with overriding of Fragments.

The direction and nature of the displacement depends more upon the fracturing force, the weight of the lower part of the limb, and the action of the muscles attached to the respective fragments, than upon the direction of the obliquity. As a rule the upper fragment is pulled forward and outward by the ilio-psoas and glutei muscles, while the lower fragment is displaced upward and inward, and is rotated outward by the combined action of the longitudinal muscles, the adductors and the weight of the limb.

*Clinical Features.*—The limb is at once rendered useless, and there is great swelling from effusion of blood in the region of the fracture. This, together with the muscularity of the part, often renders an accurate diagnosis as to the site and direction of the fracture exceedingly difficult. The shortening varies from half an inch to three or four inches—averaging about one inch in adults—and eversion is always marked. Mobility may be detected and crepitus elicited without disturbing the patient, by

placing the hand under the seat of fracture and gently attempting to raise the limb; or by fixing the upper fragment by one hand placed in front of it while the lower part of the limb is carefully lifted. It will be found that the great trochanter does not rotate with the lower segment of the femur. These tests must be employed with great caution lest the deformity be increased or the fracture rendered compound.

*Treatment.*—After reduction has been effected under an anæsthetic, extension strapping is applied from the ankle to a point well above the seat of the fracture. The thigh is then enclosed in a ferrule of Gooch splinting (Fig. 186), and a long splint applied with the limb abducted. It is often necessary to employ as much as ten or twelve pounds or more to maintain extension. Massage should be employed after the first week. The retentive apparatus should be worn for from

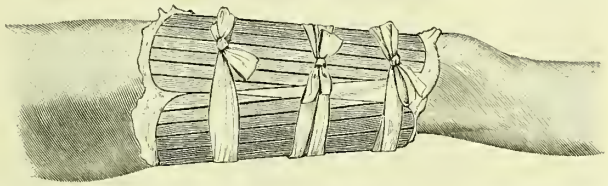


Fig. 186.—Local Gooch Splints applied for Fracture of Shaft of Femur. The splints should reach to the fold of the buttock.

six to eight weeks, after which the patient is allowed up with crutches, which he usually requires to use for three or four weeks longer, before he can bear his weight upon the limb. The old dictum of Nélaton that the treatment of fracture of the thigh should last for a hundred days is a safe working-rule. In fractures below the middle of the shaft a Thomas' knee splint answers very well. This must be worn for three or four weeks.

Hodgen's splint is an equally efficient and more comfortable means of treating this fracture.

In cases of oblique fracture, the patient should be warned that shortening to the extent of from three-quarters to one inch is liable to result, however carefully the treatment may be carried out. This does not necessarily imply a permanent limp, as by tilting the pelvis he may be enabled to walk quite well.

In many fractures of the thigh, and especially in those produced by indirect violence, the knee is sprained, and there is a considerable effusion into the joint, and this may lead to prolonged stiffness.

Union is often exceedingly slow in fracture of the femur, and may even be delayed for months. Mal-union sometimes occurs, the fracture uniting with an angular deformity outward and forward.

Refracture is very liable to occur if the patient falls or twists the limb within a few months of the original injury.

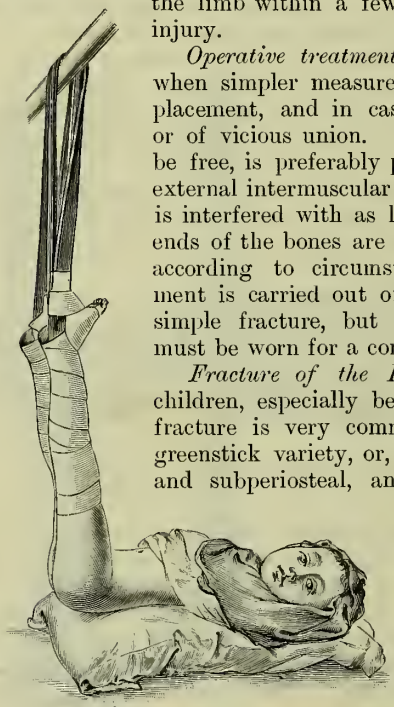


Fig. 187.—Fracture of Thigh treated by Vertical Extension.

*Operative treatment* is sometimes called for when simpler measures fail to reduce the displacement, and in cases of un-united fracture or of vicious union. The incision, which must be free, is preferably placed in the line of the external intermuscular septum; the periosteum is interfered with as little as possible; and the ends of the bones are pegged, screwed, or wired according to circumstances. The after-treatment is carried out on the same lines as for simple fracture, but the retentive apparatus must be worn for a considerably longer period.

*Fracture of the Femur in Children.*—In children, especially below the age of ten, this fracture is very common. It is often of the greenstick variety, or, if complete, is transverse and subperiosteal, and as it is accompanied by few symptoms and but little deformity, it is liable to be overlooked.

When there is displacement the deformity is similar to that in adults, and the treatment is carried out on the same lines.

In young children the nursing is greatly facilitated by applying vertical extension to both lower extremities (Fig. 187). If the fracture is transverse and shows little tendency to displacement, the local Gooch splints may be dispensed with, or replaced by a few turns of a starch bandage.

The patient may be allowed out of bed in from three to four weeks, wearing a retentive apparatus.

# CHAPTER XXVI.

## INJURIES IN THE REGION OF THE KNEE AND LEG.

*Surgical Anatomy*—Fractures of Lower End of Femur: *Supra-condylar;* T- or Y-*shaped; Separation of epiphysis; Either condyle* —Fractures of Upper End of Tibia: *Of head; Separation of epiphysis; Avulsion of tubercle of tibia*—Dislocations of Knee: *Dislocations of superior tibio-fibular joint*—Internal Derangements of Knee—Injuries of Patella: *Fractures; Dislocations*—Injuries of Leg: *Fracture of both bones; Fracture of tibia alone; Fracture of fibula alone.*

### Injuries in the Region of the Knee.

These include the supra-condylar fracture of the femur, the T- or Y-shaped fracture opening into the joint, separation of the lower femoral epiphysis; fracture of the head of the tibia, and separation of its upper epiphysis; the various dislocations and sprains of the knee, as well as its internal derangements; and fractures and dislocations of the patella.

**Surgical Anatomy.**—Of the two condyles the internal is the more prominent and palpable. On its upper edge is situated the adductor tubercle, which gives attachment to the round tendon of the adductor magnus, and which marks the level of the epiphysial line, and of the upper limit of the trochlear surface of the femur. Between the internal condyle and the inner tuberosity of the tibia, when the limb is in the flexed position, the line of the joint can be recognised as a groove or cleft, and this is made use of in measuring the length of the tibia. The outer tuberosity of the tibia can also be palpated, and must not be mistaken for the head of the fibula, which lies farther back and at a slightly lower level, and can readily be identified by tracing to it the tendon of the biceps. The tubercle of the tibia, into which the quadriceps extensor tendon is inserted, lies on the same level as the head of the fibula. In the extended position of the limb, the patella is loose and movable on the front of the trochlear surface of the femur, while in the flexed position it sinks between the condyles, resting chiefly on the outer one and becoming fixed.

The popliteal artery and vein and the internal popliteal nerve lie in close relation to the posterior aspect of the joint; and the external popliteal nerve passes behind and to the inner side of the biceps tendon.

The knee is an example of a joint which depends for its strength chiefly on its ligaments. Not only are the external and internal lateral ligaments and the posterior part of the capsular ligament particularly strong, but the crucial ligaments and the semilunar cartilages inside the cavity of the joint, further add to its stability. The powerful tendon of the quadriceps extensor muscle, in which the patella is developed as a sesamoid bone, protects and strengthens the front of the joint.

The synovial cavity extends from the level of the head of the tibia

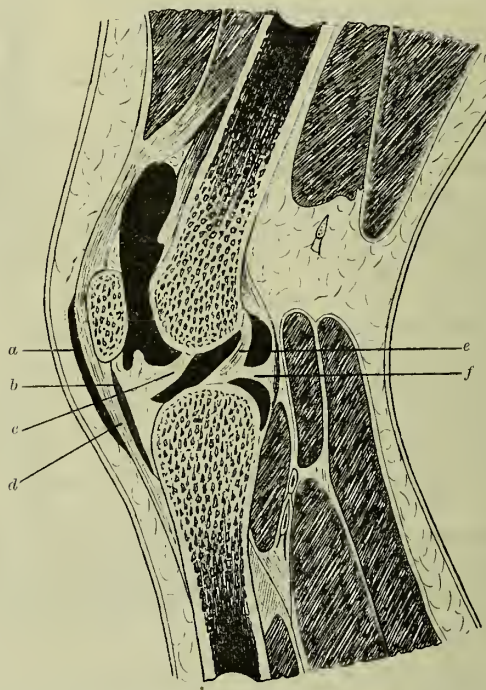



FIG. 188.—Section of Knee-Joint showing extent of Synovial Cavity.

*a*, Prepatellar bursa. *b*, Infra-patellar bursa. *c*, Ligamentum mucosum. *d*, Ligamentum patellæ. *e*, Posterior crucial ligament. *f*, Internal semilunar cartilage.

(After Braune.)

to an inch or more above the trochlear surface of the femur, passing slightly higher on the inner aspect of the joint than on the outer (Fig. 188). The large bursa between the quadriceps muscle and the femur (*sub-crural bursa*) generally communicates with the cavity of the joint. The synovial cavity of the superior tibio-fibular articulation is usually distinct from that of the knee-joint, but may communicate with it through the popliteal bursa.

A large bursa (*prepatellar*) lies over the lower part of the patella and upper part of the ligamentum patellæ; and a smaller one separates the ligamentum patellæ from the tubercle of the tibia. Several important bursæ are found in the popliteal space, one of which—the semi-membranosus bursa—sometimes communicates with the knee-joint.

## Fractures of the Lower End of the Femur.

**Supra-condylar** fracture of the femur is usually the result of a fall on the feet or knees, or of direct violence. It is most common in adults. The line of fracture is generally irregularly transverse, or it may be slightly oblique from above downwards and forwards, so that the upper fragment passes forward towards the patella, while the lower is rotated backward on its transverse axis by the gastrocnemius muscle.

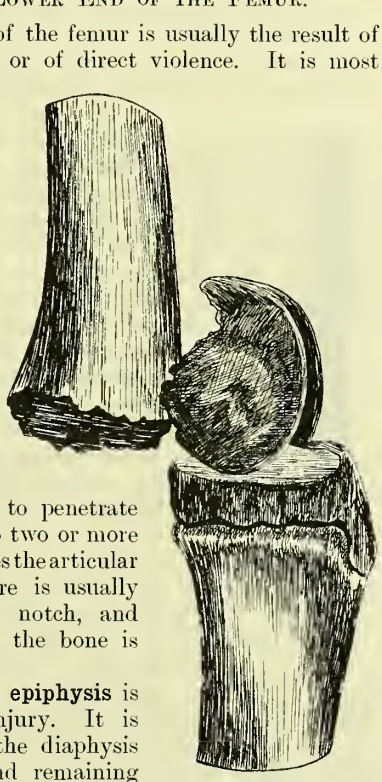


Fig. 189.—Separation of Lower Epiphysis of Femur.

(After Poland.)

The **T- or Y-shaped fracture** is, as a rule, produced by direct violence, the force first breaking the bone above the condyles, and then causing the upper fragment to penetrate the lower and split it up into two or more pieces. The fracture implicates the articular surface, and the main fissure is usually through the inter-condylar notch, and sometimes the lower end of the bone is severely comminuted.

**Separation of the lower epiphysis** is a comparatively common injury. It is seldom pure, a portion of the diaphysis usually being broken off and remaining attached to the epiphysis. It occurs usually in boys between the ages of thirteen and eighteen, as a result of severe violence such as results from the limb being caught between the spokes of a revolving wheel, or from hyper-extension of the knee. It has also been produced in attempting forcibly to rectify knock-knee and other deformities in this region, and in making traction on the limb in cases of tuberculous disease of the knee. As a rule there is little

displacement of the loose epiphysis, but it may pass in any direction, forward being much the most common (Fig. 189).

**Either condyle** may be broken off without the integrity of the shaft being destroyed, by a direct blow or fall on the knee, or by violent twisting of the leg. The separated condyle may not be displaced, or it may be pushed upwards or rotated on its transverse axis.

*Clinical Features.*—When the line of fracture traverses the joint there is an immediate effusion of blood into the synovial cavity. In fractures which are strictly extra-capsular there is frequently a copious effusion of serum into the joint. In either case, therefore, the region of the knee is greatly swollen, and the recognition of the precise nature of the injury is rendered difficult. As it is of the utmost importance to arrive at an accurate diagnosis, a general anæsthetic should be given when necessary for this purpose, and, if possible, recourse should be had to the use of the X-rays.



Fig. 190.—Separation of Lower Epiphysis of Femur, showing backward projection of lower end of diaphysis.

In the *supra-condylar fracture* the upper end of the lower fragment is usually palpable in the popliteal space, while the upper fragment is unduly prominent in front. By flexing the knee the fragments may be brought into apposition and crepitus elicited. In oblique fractures the pointed lower end of the upper fragment may transfix the quadriceps extensor muscle and may be felt under the skin, or it may perforate the skin and thus render the fracture compound. It should be disengaged by fully flexing and making traction on the knee. The thigh is shortened to the extent of from a half to one inch.

The popliteal vessels lie so close to the bone, that they are liable to be pressed upon or even torn by the displaced lower fragment. When this occurs there is great swelling in the region of the knee, with loss of pulsation in the anterior and posterior tibial arteries, and not infrequently gangrene of the limb ensues. There may also be injurious pressure on the nerves.

In the T- *or* Y-*shaped fracture* the knee is broadened, and pain and crepitus are readily elicited on moving the condyles upon one another, or on pressing them together. On moving

the patella transversely it may be felt to hitch against the edge of one or other of the fragments. The shortening may amount to one or two inches.

In *epiphysial separations* the age of the patient, the mode of injury, the finding of the smooth broad end of the diaphysis in the popliteal space (Fig. 190), or on the front of the thigh, according to the displacement, usually serve to establish the diagnosis. Abnormal mobility of the epiphysis is one of the most constant and characteristic signs of this lesion. Crepitus is of little or no value as a diagnostic sign.

In fracture of *one or other condyle* there is broadening of the knee but no shortening of the thigh, and the ecchymosis, crepitus, and pain are localised to the affected side of the joint. The knee can usually be moved towards the injured side to an abnormal extent.

*Treatment.*—Fractures in the region of the knee, especially the supra-condylar and T-shaped fractures, often present great difficulties in treatment. The small size of the lower fragment, its depth from the surface, and the accompanying effusion into and around the joint, render its control difficult if not impossible. Separations of the epiphysis are, as a rule, more difficult to reduce and to maintain in position than fractures. In the majority of cases the two fragments can only be brought into apposition when the knee is flexed on the thigh and the thigh on the pelvis, and it is almost always necessary to carry out the reduction under anæsthesia.

In the few cases in which the fragments can be accurately approximated in the extended position of the limb, retention may be effected by means of a box-splint reaching well up the thigh (p. 561).

In the majority, however, flexion is necessary, and the limb must be fixed on a double-inclined plane, so constructed that the angle of flexion can be adjusted to meet the requirements of the individual case (Fig. 179). If the lower fragment is of sufficient length to permit of extension strapping being applied to it, extension by weight and pulley, acting in the axis of the femur, and carried over an upright at the foot of the bed, may be useful. In most cases, however, this is impracticable.

A poroplastic splint moulded over the front of the limb and secured by bandages is a valuable aid in maintaining accurate apposition of the fragments, which, unless so secured, are very liable to become redisplaced.

Hodgen's splint, bent nearly to a right angle, is also found useful in the treatment of these injuries.

A careful watch must be kept on the circulation of the limb during the first few days, lest it be interfered with by the pressure of the apparatus.

In a considerable number of cases these means of retaining the fragments in apposition prove ineffectual, and it is necessary to have recourse to operative measures, mechanically securing the fragments by nails, screws, or wire sutures, after exposing the seat of fracture. Such operations entail opening the cavity of the joint, and the occurrence of septic infection may prove disastrous. Division of the tendo Achillis is not to be recommended as a means of combating the backward tilting of the lower fragment.

In all cases the retentive apparatus must be worn for about six or eight weeks, but movement and massage should be employed as soon as possible, as persistent stiffness of the knee is one of the most troublesome sequelæ of these injuries.

Compound and complicated fractures are dealt with on the general principles governing the treatment of such injuries. Amputation may become necessary should gangrene ensue from injury of the popliteal vessels, or if septic complications threaten the life of the patient.

Operative interference may be called for to rectify deformities resulting from mal-union.

After an epiphysial separation the growth of the limb is sometimes, although not always, interfered with.

### Fractures of the Upper End of the Tibia.

**Fracture of the head of the tibia** is a comparatively rare injury. It may result from a direct blow, such as the kick of a horse, or from indirect forms of violence. The line of fracture may be transverse or oblique. Occasionally the lower fragment is impacted into the upper and causes comminution. Transverse fracture of the head of the fibula sometimes accompanies fracture of the head of the tibia, and there is always considerable effusion into the knee-joint. One or other of the tuberosities may be chipped off by forcible adduction or abduction at the knee.

The ordinary clinical features of fracture are well marked, and the diagnosis is easy. From some unexplained reason this fracture usually takes a very long time, sometimes several months, to consolidate.

**Separation of the upper epiphysis** of the tibia, which includes the tongue-like process for the tubercle (Fig. 191), and the facet for the fibula, is also rare. It usually occurs

between the ages of three and nine. The displacement of the epiphysis is almost always forward or lateral, and is accompanied by the usual signs of such lesions. The growth of the limb is sometimes arrested, and shortening and angular deformity may result (Fig. 192).

*Treatment.*—After being reduced under an anæsthetic these fractures are usually satisfactorily treated in a box splint (Fig. 205), carried sufficiently high to control the knee-joint. When the head of the tibia is comminuted, light weight-extension—three or four pounds—should be used. Movement and massage are commenced within a few days, and at the end of a fortnight the patient is allowed up with crutches, wearing a moulded splint of poroplastic or plaster-of-Paris.



Fig. 191.—Separation of Upper Epiphysis of Tibia in a boy æt. 15.



Fig. 192.—Separation and Displacement of Upper Epiphysis of Tibia of old standing.

Avulsion of the **tubercle of the tibia** occasionally occurs in youths, from violent contraction of the quadriceps—as in jumping. The limb is at once rendered powerless, and the osseous nodule can be felt, and on moving it crepitus is elicited.

This is best treated by pegging the tubercle in position, and fixing the limb on an inclined plane to relax the quadriceps muscle.

The **upper end of the fibula** is seldom broken alone. Its chief clinical interest lies in the fact that it may implicate the external popliteal nerve, and cause drop-foot.

### Dislocations of the Knee.

Dislocation of the knee occurs only as a result of extreme degrees of violence, especially of a wrenching or twisting character

Antero-posterior dislocations are more common than those which are lateral, and are more frequently complete. A considerable proportion of all varieties are compound, and the damage to the contents of the popliteal space is often so great as to necessitate primary amputation.



FIG. 193.—Forward Dislocation of Knee.

(Specimen in Professor Annandale's collection.)

The varieties are named in terms of the direction in which the tibia passes.

**Dislocation forward** is the most common variety (Fig. 193), and results from sudden hyper-extension of the knee. It is often compound through a wound in the popliteal space. The leg remains fully extended, and lies on a plane anterior to that of the thigh.

The condyles are distinctly palpable posteriorly, and the

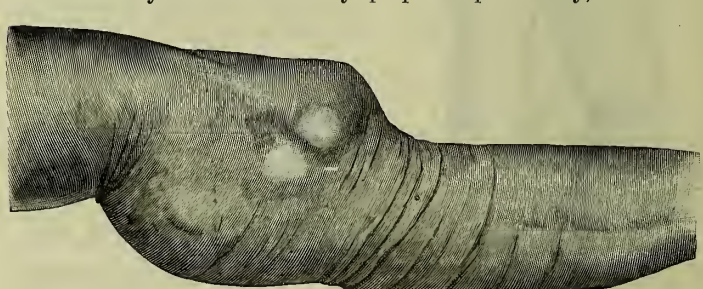


FIG. 194.—Backward Dislocation of Knee.

(Dr. Mills-Roberts' Case.)

skin is tightly stretched over them, or may even be torn. The patella is projected forward, and the skin above it is thrown into transverse folds.

**Dislocation backward** (Fig. 194) is usually due to a direct blow driving one of the bones past the other. The leg remains hyper-extended, the head of the tibia occupies the popliteal

space, while the lower end of the femur projects forward with the patella either in front or to one side of it.

The **lateral dislocations** are generally incomplete. In the *inward* variety the outer condyle forms a prominence, with a depression over the normal position of the heads of the tibia and fibula; in the *outward*, the bones of the leg project on the outer side, the depression being above them.

*Treatment.*—These dislocations differ from most others in that no special manipulations are necessary to restore the displaced bone to its place, and that reduction does not take place with a distinct snap.

If the patient is fully anæsthetised, while traction is made on the leg and counter-traction on the thigh with the knee in the flexed position, reduction can usually be effected by manipulating the bones into position.

In antero-posterior dislocations the limb should be flexed and placed on a pillow, movement and massage being employed from the first. The patient is usually able to walk about within a month.

In lateral dislocations, after reduction has been effected, there is at first considerable tendency to redisplacement, and it is therefore necessary to secure the joint in a box splint for about fourteen days, after which massage and movement are employed. It is usually about six weeks before the patient can use the limb with freedom.

In compound dislocations, and in those complicated by injury to the popliteal vessels, the question of amputation has to be considered.

**Dislocation of the Superior Tibio-Fibular Articulation.**—This joint may be dislocated by twisting forms of violence applied to the foot or leg, or by forcible contraction of the biceps muscle. The displacement may be forward or backward, and the head of the fibula can be felt in its new position with the prominent tendon of the biceps attached to it. The movements of the knee are quite free, but the patient is unable to walk on account of pain. Reduction and retention are, as a rule, easy, and the ultimate result satisfactory. We have frequently met with this injury accompanying compound fractures of both bones of the leg resulting from railway and similar accidents.

By applying direct pressure over the displaced bone with the knee flexed, the dislocation is easily reduced. It is kept in position by a few strips of adhesive plaster, a firm bandage, or a light rigid splint, such as poroplastic or Croft's plaster-of-Paris splint.

Very rarely the fibula is separated from the tibia at both ends (**total dislocation**) and displaced upwards. Bennett, of Dublin, has pointed out that in some persons the upper end of the fibula does not reach the facet on the tibia—a condition which might be mistaken for a dislocation.

### Injuries of the Semilunar Cartilages.

The semilunar cartilages are two crescentic plates which lie upon the upper end of the tibia, and serve to deepen the articular surface for the condyles of the femur. Each cartilage is firmly attached to the tibia by its anterior and posterior ends, and, through the medium of the coronary ligaments, is loosely attached along its peripheral, convex edge to the head of the tibia, the internal cartilage being connected also to the capsular ligament of the joint. The tendon of the popliteus muscle intervenes between the external cartilage and the capsule. The central, concave edges of the cartilages are thinned out and are unattached.

Owing to the looseness of their attachments, the cartilages enjoy a certain limited range of movement within the joint, passing backwards during flexion, and forwards again when the limb is extended. While the limb is partially flexed, a slight degree of rotation of the leg at the knee is possible, and during this movement the cartilages glide from side to side.

Any abnormal laxity of the ligaments of the joint may render the cartilages unduly mobile, so that they are liable to be displaced from comparatively slight causes, and when so displaced it is not uncommon for one or other of the cartilages to be torn by being nipped between the femur and the tibia. It is convenient to consider these "internal derangements of the knee-joint" separately, according to whether the cartilage is merely abnormally mobile, or is actually lacerated.

**Mobile Cartilage—Displacement of Internal Semilunar Cartilage** (Fig. 195).—The *internal* semilunar cartilage exhibits undue mobility much more frequently than the external, and the condition is usually met with in adult males who engage much in athletics, or who follow an employment which entails working in a kneeling or squatting position for long periods, with the toes turned outwards—for example, coal-miners. The internal lateral ligament, and through it the coronary ligament, is thus gradually stretched, so that the cartilage becomes less securely anchored, and is rendered liable to be displaced towards the interior of the joint during some sudden

movement which combines flexion of the knee with internal rotation of the femur upon the tibia, as, for example, in rising quickly from a squatting position, or turning rapidly and pushing off with the foot, in the course of some game such as football or tennis. It may occur also from accidentally kicking a loose stone or slipping off the kerbstone.

What actually happens when the cartilage is displaced would appear to be, that the combined flexion and abduction of the knee opens up the inner side of the joint by separating the internal condyle from the inner tuberosity of the tibia, and that the internal cartilage in its movement backward during flexion slips under the condyle and is caught between it and the

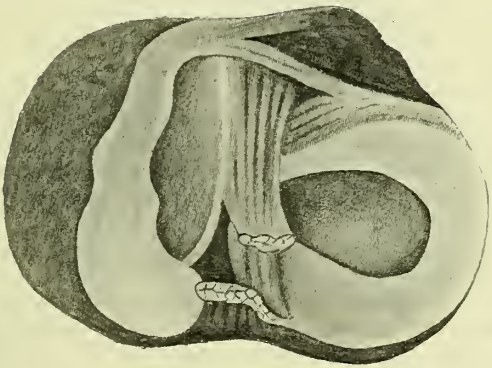


Fig. 195.—Displacement of Right Internal Semilunar Cartilage towards the Centre of the Joint.

tibia. It may even slip past the condyle and into the intercondyloid notch and come to lie against the crucial ligaments.

The mechanism by which this lesion is produced doubtless explains the greater frequency with which the *left* knee is affected, as most sudden movements are made from right to left, thus throwing the strain upon the left knee.

*Clinical Features.*—When the patient is seen immediately after the accident has happened, it will usually be found that while making some sudden movement, he was seized with an intense sickening pain in the knee, accompanied, it may be, by a sensation of something giving way with a distinct crack, and followed by locking of the joint. The patient usually falls and may be unable to rise again. The knee is found to be fixed in a slightly flexed position ; and while the surgeon may be able

to carry out movements of flexion to a considerable extent without increasing the pain, any attempt to extend the joint completely is extremely painful. Tenderness may be elicited on making pressure over the inner edge of the ligamentum patellæ in the groove between the femur and tibia. Considerable effusion rapidly takes place into the synovial cavity. As a rule little is to be learned by palpation.

The condition is to be diagnosed from sprain of the joint, particularly from that of the internal lateral ligament which it most resembles.

*Treatment.*—To reduce the displacement the patient is placed on a couch and, after the knee is fully flexed, the leg is rotated outward and abducted, to separate the internal condyle from the tibia, and while the rotation and abduction are maintained the leg is quickly extended. The return of the cartilage to its place is sometimes attended with a distinct snap, but in other cases reduction is only recognised to have taken place by the fact that the joint can be fully extended without causing the patient pain.

Alternate flexion and extension combined with rotatory movements is sometimes successful. Several attempts are often necessary, and a general anæsthetic may be called for. After reduction the limb is fixed with sand-bags, and massage and movement employed, great care being taken that no rotatory movement is permitted at the knee. Prolonged rest and support are necessary to allow of repair of the torn ligaments. When the patient begins to use the joint he must be careful to avoid movements which throw strain on the weakened ligaments.

In a considerable proportion of cases so treated no recurrence takes place, and in the course of a month or two the patient is able to resume an active life with a perfectly useful joint.

**Recurrent Displacement.**—In cases of recurrent displacement, each attack is accompanied by symptoms similar in kind to those above described, but less severe, and the patient usually learns to carry out some manipulation by which he is able to return the cartilage into position. He seeks advice with a view to having something done to prevent displacement occurring, and to restore the stability of the joint, which, in many cases, is impaired, preventing him following his occupation. The symptoms closely resemble those of a pedunculated "loose body," and it is often difficult to differentiate between them. In the case of a body free in the cavity of the joint, the site of the pain may vary in different attacks, and the body can sometimes be palpated.

Attempts may be made to retain the cartilage in position by

pads, bandages, or other forms of apparatus, so arranged as to prevent rotation and lateral movement at the knee. In the majority of cases, however, the best results are obtained by exposing the cartilage by an incision in its long axis, and excising it, in whole or in part, as may be necessary. The capsule is closed by a row of buried catgut sutures, and the wound stitched without drainage.

The limb is fixed on a splint for about a fortnight, after which the patient is allowed to move it in bed. At the end of three weeks he is allowed up, wearing an elastic bandage. In the course of two or three months he may resume an active

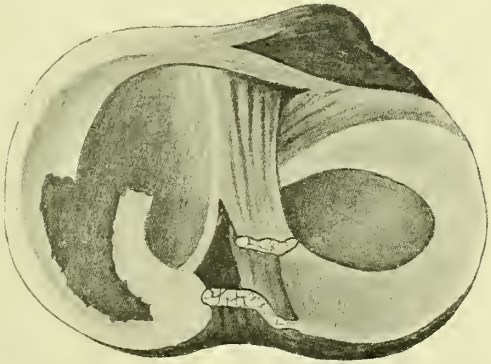


Fig. 196.—Longitudinal Tear of Posterior End of Right Internal Semilunar Cartilage.

life, and it is seldom found that the joint is in any way impaired.

**Displacement of the external cartilage** is comparatively rare. It is in every way comparable to displacement of the internal cartilage, and is treated on the same lines.

**Torn or Lacerated Cartilage.**—In a large proportion of cases of displaced cartilage in which the condition assumes the recurrent type, it is found on opening the joint, that, in addition to being unduly mobile, the cartilage is torn or lacerated. The experience of different surgeons varies regarding the nature of the laceration. In our experience the most common form has been a longitudinal split, whereby a portion of the inner edge of the cartilage was separated from the rest and projected as a tag towards the cavity of the joint (Fig. 196). As a rule, it is the anterior end which is torn, less frequently the posterior end. Sometimes the cartilage is split from end to end, the outer

crescent remaining in position, while the inner crescent passes in between the condyles and lies curled up against the crucial ligaments. Occasionally the anterior end is torn from its attachment to the tibia, less frequently the posterior end. In one case we found the cartilage separated at both ends and lying outside the joint.

The *clinical features* are similar to those of mobile cartilage with displacement, and as a rule the nature of the lesion is only discovered after opening the joint.

The *treatment* consists in excising the loose tag or the whole cartilage, according to circumstances. It is never advisable to attempt to stitch the torn portion in position.

**Rupture of the Crucial Ligaments.**—A few cases have been recorded in which, as a result of severe twisting forms of violence, the crucial ligaments have been torn from their attachments, leaving the joint loose and unstable, so that the tibia and the femur may be moved laterally on one another. When the disability persists the joint may be opened and the ligaments sutured in position (Mayo-Robson).

**Sprains** of the knee are comparatively common as a result of sudden twisting or wrenching of the joint. In addition to the stretching or tearing of the ligaments, there is usually a considerable effusion of fluid into the synovial cavity. The swelling which results fills up the hollows on either side of the patella, and extends for some distance in the synovial pouch underneath the quadriceps tendon. The patella is raised from the front of the femur by the collection of fluid in the joint—"floating patella"—and if firmly pressed upon, it may be made to rap against the trochlear surface.

A sprain is to be diagnosed from separation of one or other of the adjacent epiphyses, fractures involving the articular ends of the bones, and displacement of the semilunar cartilages. On account of the swelling which obscures the outline of the part, the differential diagnosis is often difficult. Chief reliance is to be placed upon the bones retaining their normal relationships, and upon the fact that the points of maximum tenderness are over the attachments of the lateral ligaments. As the internal lateral ligament suffers most frequently, the most tender spot is usually over its attachments to the inner aspect of the head of the tibia—less frequently over the internal condyle.

Unless efficiently treated a sprain of the knee is liable to result in weakness and instability of the joint from stretching of the ligaments, and this is often associated with effusion of fluid in the synovial cavity (*traumatic hydrops*). This is more likely

to occur if the joint is repeatedly subjected to slight degrees of violence, such as are liable to occur in football or other athletic exercises—hence the name "footballer's knee" sometimes applied to the condition.

*Treatment.*—In recent and severe cases the patient must be confined to bed, and firm pressure applied over the joint by means of an elastic bandage and a pad of cotton wool. This may be removed once or twice a day to admit of the joint being douched with hot or cold water, and at the same time the joint should be massaged and moved to promote absorption of the effusion and prevent the formation of adhesions.

When there is chronic effusion into the joint, the best results are obtained by rest and blistering. If the patient is unable to lie up, massage should be systematically employed, and a firm elastic bandage worn. A patient who has once had a severe sprain of the knee, or who has developed the condition of "footballer's knee," must give up violent forms of exercise which expose him to further injuries, otherwise the condition is liable to be aggravated and to result in permanent impairment of the stability of the joint.

## INJURIES OF THE PATELLA.

**Fracture of the patella** is a comparatively common injury in adult males. Most frequently it is due to *muscular action*, the patella being snapped across the lower end of the femur by a sudden and forcible contraction of the quadriceps extensor muscle taking place while the limb is partially flexed—as, for example, in the attempt to save one's self from falling backward. The bone is then broken as one breaks a stick by bending it across the knee, and the line of fracture, which is transverse or slightly oblique, crosses the bone a little below its middle. Fractures produced in this way are almost never compound.

The degree of displacement of the fragments depends upon the extent to which the lateral expansions of the quadriceps tendon are lacerated. As a rule they are but slightly torn, so that the separation of the fragments does not exceed an inch. In other cases they are widely torn, and the contraction of the quadriceps muscle is then able to separate the fragments by three or four inches, and sometimes causes tilting of the upper fragment. The blood effused into the joint tends still further to increase the separation. As the periosteum is usually torn at a level lower than the fracture, its free ends hang as a fringe from the

upper fragment, and by getting between the broken ends may form a barrier to firm osseous union (Macewen).

*Clinical Features.*—Immediately the bone breaks the patient falls, and he is unable to rise again as the limb is at once rendered useless. The power of extending the limb is lost, and the patient is unable to lift his heel off the ground. The knee-joint is filled with blood and serous effusion, which usually extend into the bursa under the quadriceps. The two fragments can be detected,



Fig. 197.—Radiogram of Fracture of Patella.
(Lent by Mr. George Hamilton, of Liverpool.)

separated by an interval which admits of the finger being placed between them, and which is increased on flexing the knee. On relaxing the quadriceps the fragments may be approximated more or less completely.

*Prognosis.*—In cases with little displacement, if the fragments have been kept in perfect apposition osseous union may take place, but in the great majority of cases, the union is fibrous. In certain cases, the shortening of the quadriceps and the gradual stretching and thinning of the connecting fibrous band may allow of further separation of the fragments (Fig. 198), which to a variable extent interferes with the stability and functions of the limb. The upper fragment sometimes becomes attached to the front of the femur, and moves with it in extension, and the fibrous band between the two fragments gradually becomes

stretched. It is not uncommon for the patella to be refractured by a fall within a month or two of a previous fracture.

*Treatment.*—The best method of treating a fracture of the patella is still *sub judice*. It is probably true that the best functional results are most speedily obtained by operative measures. The laceration of the lateral aponeurosis, the tilting of the fragments, and the interposition of the torn periosteum between the fragments, can in no other way be rectified with certainty. The operation, however, should only be undertaken by those who are thoroughly familiar with wound technique, and who have every means at their disposal for carrying it out.

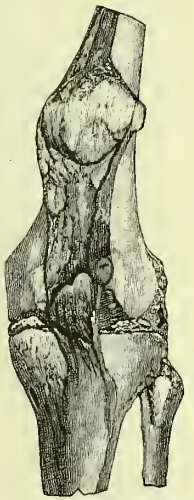


FIG. 198.—Fracture of Patella, showing wide separation of fragments, which are united by a fibrous band.

(Anatomical Museum of the University of Edinburgh.)

*Non-operative Treatment.*—In the majority of cases occurring in patients who do not follow a laborious occupation or otherwise lead an active life, a satisfactory result can be obtained without having recourse to operation. We have recently employed the following method, and have reason to be satisfied with it :—

The patient is kept in bed for a few days, the injured region being supported on a pillow and massaged daily. About the fourth day a strip of adhesive plaster, three inches wide, is applied so as to encircle the thigh in the lower third (Wharton Hood). The patient is then allowed to use the limb with caution. As osseous union of the fragments is not an essential to success in treatment, and as fibrous union does not necessarily entail any material interference with the utility of the limb, no attempt need be made to approximate the fragments, but every effort must be made to maintain the function of the quadriceps muscle and the mobility of the joint.

In the opinion of some surgeons an attempt should be made to bring the fragments into contact, and to secure osseous union.

The limb is placed upon an inclined plane to relax the quadriceps muscle, and means are taken to arrest effusion and to diminish the swelling of the joint by systematic massage and a supporting bandage. When, in the course of a few days,

this has been accomplished, the attempt is made to approximate the fragments, by fixing a large horseshoe-shaped piece of adhesive plaster to the front of the thigh, embracing the upper fragment. Extension is made upon this by means of rubber tubing, which is fixed to the foot-piece of the splint (Fig. 199). The bandage which binds the limb to the splint should make upward pressure on the lower fragment, or this may be done by a special piece of adhesive plaster with elastic tubing pulling in an upward direction.

The retentive apparatus is kept on for about three weeks, and a rigid, but easily removable, apparatus is thereafter applied, and the patient allowed up on crutches, the limb being massaged and exercised daily to improve the tone of the muscles.

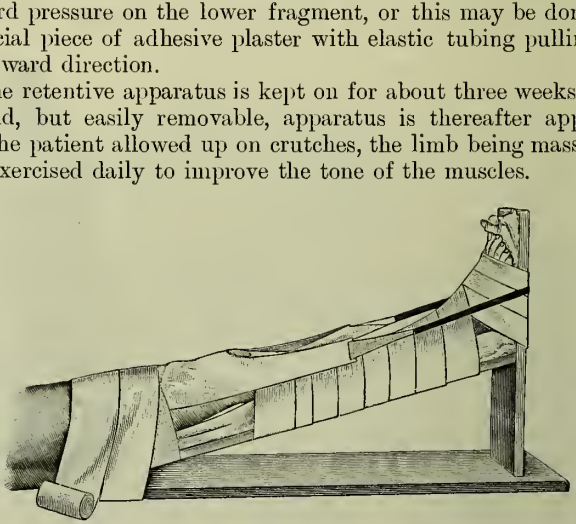


Fig. 199.—Treatment of Fracture of Patella by means of Inclined Plane and Elastic Extension.

*Operative Treatment.*—This is specially indicated in young subjects who lead an active life, and in labouring men, particularly those who follow dangerous employments necessitating great stability of the knees.

A vertical or semilunar incision is made through the skin and fascia, and the fragments exposed. All blood-clot is removed from the joint, the periosteum is reflected from between the fragments, and any clot or loose portions of bone lying between them removed. The fragments are then approximated by suturing the bone directly with silver wire, which is passed through the fragments transversely (G. Hamilton), in such a way as to avoid piercing the articular cartilage and encroaching on the cavity of the joint. When the fracture is comminuted, or the bone liable to be split in the drilling process, the suture may be applied circumferentially round the patella, pass-

ing through the quadrieeps tendon above and the ligamentum patellæ below, keeping as near to the bone as possible. Whieh-ever method is adopted, the periosteum should be stiteheđ over the fraeture, and the tear in the aponeurosis elosed with fine eatgut sutures. The limb is fixed on a suitable splint.

So soon as the wound is healed—in a week or ten days—the splint is removed and massage and movement of the limb commeneed, and the patient may be allowed to move his limb in bed. At the end of another week he may be allowed up with sticks or erutehes.

When the fraeture is eaused by *direct violence*, sueh as a fall on the knee or the kiek of a horse, it may be transverse, oblique, or vertieal, but in many cases it is stellate, the bone being broken into several irregular pieees. These eomminuted fraetures are frequently compound. In transverse and oblique fraetures the displaeement depends upon the same causes as in fracture by muscular action. In vertieal and stellate fractures, unless the knee has been forcibly flexed after the bone has been broken, there is little or no displacement. The treatment is governed by the same eonsiderations as in fractures by muscular action.



Fig. 200.—Old-standing Fracture of Patella with wide separation of fragments.

The patient was able to follow his occupation as a dock-labourer.

*Old-standing Fractures.*—As fibrous union, even with an interval of several inehes between the fragments, is not incompatible with a useful limb (Fig. 200) it is not often necessary to operate for this eondition. When the usefulness of the limb is seriously impaired, however, it may be neeessary to operate. The operation is earried out on the same lines as that for reeent fracture, the ends of the bones being rawed and adhesions divided. When the upper fragment has become attaehed to the femur it may be neeessary to separate it, and it is sometimes

necessary to lengthen the quadriceps muscle by making a number of V-shaped incisions through its substance, before the fragments can be approximated.

When operative treatment is contra-indicated, the patient should be fitted with a firm apparatus which will limit flexion of the knee and support the fragments.

**Dislocations of the patella** are rare. They result from exaggerated muscular movements when the limb is in the fully extended position, or from a blow on one or other edge of the bone. Laxity of the ligaments and knock-knee are predisposing factors. They are sometimes associated with fracture of the edge of the trochlear surface, which renders retention in position difficult.

The *outward* is the most common variety—the *inward* being

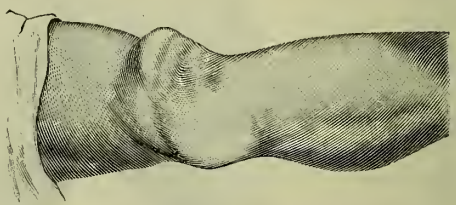


Fig. 201.—Vertical Dislocation of Patella.

rare. Either may be complete or incomplete. Sometimes the bone is rotated so that its edge rests on the front of the femur —*vertical* dislocation (Fig. 201); and in a few cases it has been completely turned round, so that the articular surface is directed forwards.

*Clinical Features.*—The joint is fixed, usually in a position of slight flexion, and the displaced patella can readily be palpated. The deformity is a very striking one, and at first sight suggests a much more serious injury. Although easily reduced, the dislocation is liable to recur.

To effect reduction, the quadriceps must be thoroughly relaxed by extending the leg upon the thigh and flexing the thigh upon the pelvis. If the patella be now tilted by making firm pressure on that edge which lies furthest from the middle of the joint, and at the same time pushed towards the middle line, it usually slips into position without difficulty. The limb is placed on a posterior splint, and firm elastic pressure made on the joint to prevent or diminish effusion. Massage and movement are carried out from the first.

As the displacement is liable to recur, the patient should wear a firm elastic bandage or a strong knee-cap.

*Permanent and recurrent dislocations of the patella* will be described in the chapter on deformities.

## Fractures of the Bones of the Leg.

The bones of the leg may be broken together or separately.

**Fracture of both Bones.**—The anatomical and clinical features of this injury depend to a large extent upon the nature of the violence producing it. In fracture by *direct* violence, such as the passage of a wheel over the limb or a severe blow, the bones give way at the point of impact, and the line of fracture tends to be transverse, both bones being broken at the same level (Fig. 202). There is often little or no displacement, and such as there is is angular, and is determined by the direction of the fracturing force.

When the violence is *indirect*, as from a fall on the feet, or a twist of the foot, the tibia usually gives way at the junction of its lower and middle thirds, and the fibula at a higher level (Fig. 203). Torsion of the tibia is probably the most important factor in the production of the fracture, the lower fragment being fixed by the pressure of the foot upon the ground, while the upper fragment is rotated by the impetus of the body. Both fractures are usually oblique—that in the tibia running from above downward, forward, and inward, and it is generally found that the obliquity of the fibular fracture corresponds with that in the tibia.

There is usually considerable displacement. The upper fragments project forwards, while the lower fragments tend to move backwards under the influence of gravity and the traction of the calf muscles. These muscles also pull up the heel and point the toes, and the weight of the foot causes it to fall outwards.

On account of the superficial position of the tibia and the pointed character of the fragments, this fracture is frequently rendered compound by the bone coming through the skin. The projecting piece of bone is usually the lower end of the upper fragment. This fracture is also very often comminuted. It has been observed that when the line of fracture forms the letter V on the subcutaneous surface of the tibia, there is invariably a fissure passing along the back of the bone into the ankle-joint—a complication which adds to the risk of subsequent stiffness and impaired usefulness of the limb. Apart from this, the ankle is usually sprained in fractures by indirect violence, and

we have frequently found the superior tibio-fibular articulation torn open in severe fractures of both bones of the leg.

*Clinical Features.*—The tibial fracture is readily recognised by detecting an irregularity on running the fingers along the crest of the shin, and at this point abnormal mobility, tenderness, and crepitus can usually be elicited (Fig. 204). The condition of the fibula is usually to be inferred by noting the amount of deformity, and the extent of mobility of the tibial fragments. It is often difficult to make out the fibular fracture, and it is not always advisable to attempt to do so, especially if the necessary manipulations cause pain or tend to increase the displacement. Not infrequently the seat of fracture may be recognised by detecting a point at which pain is elicited on making pressure over the bone some distance off—pain on distal pressure.



Fig. 202.—Transverse Fracture of both Bones of Leg by direct violence. United.

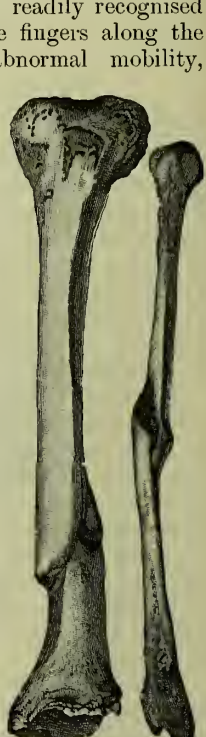


Fig. 203.—Oblique Fracture of both Bones of Leg by indirect violence. United.

On account of the close connection of the skin to the periosteum on the subcutaneous aspect of the tibia, the tension caused by extravasated blood is often extreme, and blisters frequently form over the area of ecchymosis. When infected by bacteria these are liable to lead to sloughing of the skin, and the fracture may in this way be rendered compound.

The vessels and nerves of the leg are seldom seriously damaged.

*Treatment.*—Reduction is most satisfactorily accomplished under anæsthesia. Traction is made upon the foot and the fragments are manipulated into position, the pointing of the toes and the outward rotation of the foot being at the same

time corrected. The normal outline of the leg is restored when the ball of the great toe, the internal malleolus, and the inner edge of the patella are in the same plane.

The retentive apparatus to be applied depends upon the tendency to redisplacement, the degree of swelling, and the extent of the damage to the skin.

In transverse fractures with a moderate amount of swelling and intact skin, the limb may immediately be enclosed in a rigid apparatus, such as lateral poroplastic splints retained in position by an elastic bandage or a Croft's splint, which admits of massage being carried out from the first. When the fracture is in the lower third of the leg the ambulatory splint (Fig. 210) gives excellent results, and is of special service in hospital practice. This splint allows of a certain amount of movement



Fig. 204.—Recent Fracture of both Bones of Leg in Lower Third by direct violence.

of the muscles, and it is usually found when it is removed at the end of three or four weeks that the ankle is freely movable and there is no atrophy of muscles.

When the fracture is oblique and it is difficult to retain the fragments in position, or when there is great swelling with bullæ or bruises on the skin, a splint which admits of easy access to the limb is to be preferred. One of the simplest and most efficient is the box splint (Fig. 205). This consists of two pieces of wood extending from above the knee to an inch or two beyond the sole, and a little broader than the maximum diameter of the leg. These are rolled into the opposite ends of a folded sheet so as to form two sides of a box, of which the sheet constitutes a third side. It is found advantageous to insert another board, fitted with a foot-piece, between the folds of the sheet forming the third side of the box, to add to the rigidity of the splint, and to aid in controlling the foot. By folding one side of the sheet somewhat obliquely, the box is

made a little wider at the knee than at the ankle, and so fits the limb more accurately.

The limb is placed in this box, the sides of which have been carefully padded. Pressure is taken off the condyles, the head of the fibula, the malleoli, and the tip of the heel by ring pads, and a large supporting pad is placed behind the tendo Achillis. A folded towel is laid over the front of the leg, forming a lid to the box, and the whole is bound to the limb by three slip-

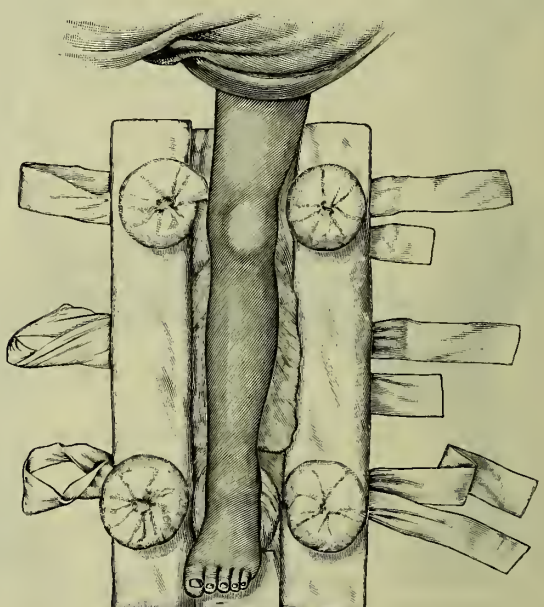


Fig. 205.—Box Splint for Fractures of Bones of Leg.

knots. Finally, the foot is fixed at right angles to the leg by a figure-of-eight bandage or a piece of elastic webbing. Sand-bags placed alongside serve to steady the limb. In fractures in the lower third of the leg, the box splint may stop short of the knee, and the limb may then be suspended in a Salter's cradle, which allows the patient to move about more freely in bed.

To prevent shortening in oblique fractures and in those near the ankle-joint, where it is often difficult to control the lower fragment, extension, applied by weight and pulley, may be of service. The strapping may be applied only to the

lower fragment, but we prefer to carry it to the upper third of the leg.

When the skin is damaged, as it so frequently is on the inner aspect of the tibia, antiseptic and protective dressings must be applied to prevent septic infection, and to promote healing.

Massage is carried out daily so soon as the condition of the skin will admit of it, and, to prevent stiffness, the ankle is moved from the first. In the course of three weeks, lateral poroplastic splints retained by an elastic bandage may be substituted, and the patient allowed up on crutches. In simple fractures without displacement union is usually complete in from six to eight weeks, but when the fracture is oblique, comminuted, or compound, union is often delayed, and the functions of the limb may not be regained for three or even four months after the accident.



Fig. 206.—A Badly-united Fracture of both Bones of Leg, occurring in a lad who had had no treatment.

*Operative Treatment.*—When overriding cannot otherwise be corrected it is advisable to secure the fracture mechanically by operation. A curved incision with its convexity backward is made over the inner side of the tibia, exposing the fragments, which are then screwed, pegged, or wired according to circumstances. It is seldom necessary to deal specially with the fibula. A box splint is applied till the wound has healed, after which a Croft's splint is substituted and massage commenced.

We do not share in the dissatisfaction expressed by some surgeons, notably Arbuthnot Lane, as to the results obtained by non-operative means in these fractures, and do not recommend a systematic resort to operative treatment.

*Un-united fracture* of the bones of the leg is sometimes met with. It is treated on the same lines as in other situations, but may prove extremely intractable, especially in the case of children, in whom indeed it is sometimes incurable.

*Mal-union* (Fig. 206), on account of the disability it entails, may call for operative treatment in the form of osteotomy of one or both bones.

*Compound fractures* are treated on the lines already laid down for the treatment of compound fractures in general.

**Fracture of the tibia alone** is almost always due to direct violence or to a twist of the foot. As the fracture is transverse there is little displacement, and as the intact fibula retains the fragments in position, union takes place rapidly and without deformity. Oblique fracture from indirect violence is extremely rare.

**Fracture of the fibula alone** may result from direct violence, and, on account of the support given by the tibia, is usually unattended by displacement or deformity. Bennett, of Dublin, has pointed out that it is common to meet with an oblique fracture of the upper third of the fibula as the result of an outward twist of the ankle while the foot is extended. This fracture is characterised by pain localised at the seat of the break, on moving the foot in such a way as to bring the astragalus to bear against the fibula. Local pressure also may make the fibula yield and may elicit crepitus. In some cases this fracture is associated with injuries in the region of the ankle-joint. This fracture is very often overlooked, and from want of proper treatment results in prolonged impairment of usefulness of the limb.

*Treatment.*—Fractures of the tibia or fibula alone are treated on the same lines as fractures of both bones. The ambulant method of treatment is particularly useful in these cases (Fig. 210).

# CHAPTER XXVII.

## INJURIES IN REGION OF ANKLE AND FOOT.

Surgical anatomy — Fractures: *Pott's fracture; Converse of Pott's fracture; Separation of lower epiphysis; Fracture of astragalus; Fracture of os calcis; Fractures of other tarsal bones; Fractures of metatarsal bones; Fractures of phalanges*— Dislocations: *Of ankle-joint; Of inferior tibio-fibular joint; Complete dislocation of astragalus; Sub-astragaloid dislocation; Medio-tarsal dislocation; Tarso-metatarsal dislocation; Dislocations of toes.*

The fractures in this region include Pott's fracture, and its converse; separation of the lower epiphysis of the tibia; fractures of the astragalus, os calcis, and other tarsal bones; and fractures of the metatarsals and phalanges. Various dislocations also occur, the most important being those of the ankle-joint, of the astragalus, and the sub-astragaloid dislocation.

**Surgical Anatomy.**—In studying the injuries in the region of the ankle-joint it is of importance to understand the terms which are employed in describing the movements of the foot. Thus by *flexion* or *dorsiflexion* is meant that movement which approximates the dorsum of the foot to the front of the leg; while *extension* or *plantar flexion* means the drawing up of the heel so that the toes are pointed. In *inversion* the inner edge of the foot is drawn up so that the sole looks inwards, an attitude which is analogous to supination of the hand. In *eversion* the outer edge of the foot is drawn up, the sole looking outwards—analogous to pronation of the hand. *Adduction* indicates the rotation of the foot so that the toes are turned towards the middle line; while in *abduction* the toes are turned away from the middle line.

The most prominent bony landmarks in the region of the ankle are the two *malleoli*, the external lying slightly further back, and about half an inch lower than the internal. On the inner side of the foot from behind forward may be felt the *internal tuberosity* of the os calcis; the *sustentaculum tali*, which lies about one inch vertically below the tip of the malleolus; the *tubercle of the scaphoid*, about an inch in front of the malleolus, and at a slightly lower level; the *internal cuneiform*, and the base, shaft, and head of the *first metatarsal*.

On the outer side may be recognised the *external tuberosity* of the os calcis, the *peroneal tubercle* on the same bone; the *cuboid*; and the prominent base of the *fifth metatarsal*.

The astragalo-scaphoid joint lies immediately behind the tubercle of the scaphoid, and a line drawn straight across the foot at this level passes over the calcaneo-cuboid joint.

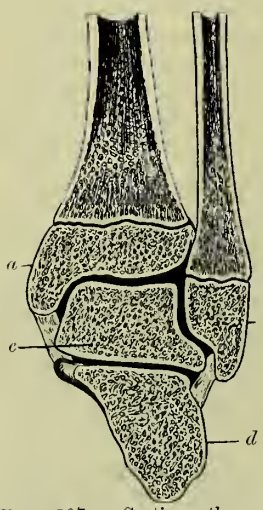



Fig. 207. — Section through Ankle-Joint, showing relation of epiphyses to synovial cavity.

*a*, Lower epiphysis of tibia.
*b*, Lower epiphysis of fibula.
*c*, Astragalus.
*d*, Os calcis.

(After Poland.)

The *ankle-joint*, formed by the articulation of the tibia and fibula with the astragalus, lies about half an inch above the tip of the internal malleolus, and is so constructed that when the foot is at a right angle with the leg, it is only possible to flex and extend the joint. When the toes are pointed, however, slight lateral and rotatory movements are possible. The chief seat of lateral movement of the foot is at the astragalo-scaphoid and calcaneo-cuboid articulations — "the mid-tarsal or Chopart's joint."

The ankle-joint owes its strength chiefly to the malleoli and the external and internal lateral ligaments, and to the inferior tibio-fibular ligaments which bind together the lower ends of the bones of the leg. The numerous tendons passing over the joint on every side also add to its stability.

The synovial membrane of the ankle-joint passes up between the bones of the leg to line the inferior tibio-fibular joint; but it is distinct from that of the inter-tarsal joints, which communicate with one another in a complicated manner. The epiphysial line at the lower end of the fibula lies on the level of the astragalo-tibial articulation, while that of the tibia is about half an inch higher (Fig. 207).

## Fractures in the Region of the Ankle.

**Pott's Fracture.**—It must clearly be understood that various lesions occurring in the region of the ankle-joint are included under the clinical term "Pott's fracture." Although of a similar nature, and produced by similar forms of violence, these vary considerably in their anatomy and clinical features. They are all the result of *combined eversion and abduction* of the foot—produced, for example, by the foot slipping off the kerbstone, or by the patient jumping from a height and landing on the inner side of the foot.

When forcible *eversion* is the chief movement, the tightening of the internal lateral ligament usually tears off the internal malleolus across its base. The astragalus is then brought to

bear on the external malleolus, and the inferior tibio-fibular ligament may rupture, or the outer portion of the tibia to which it is attached may be avulsed. This form is sometimes called *Dupuytren's fracture.* The force continuing to act, the lower end of the fibula is pressed outwards and breaks close above the malleolus. When the bones are widely separated in Dupuytren's fracture the astragalus may be forced up between them.

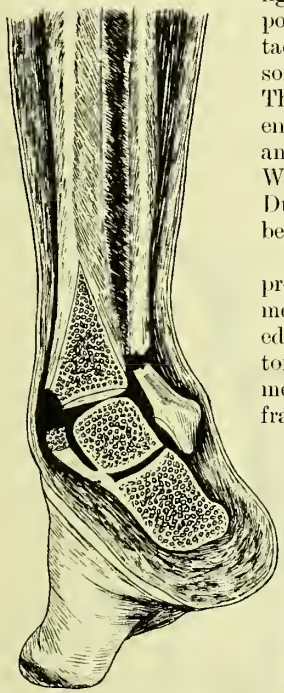


Fig. 208.—Diagram of Pott's Fracture from behind.

(After Helferich.)

When the movement of *abduction* predominates, the internal lateral ligament is usually ruptured, or the anterior edge or tip of the internal malleolus torn off. The inferior tibio-fibular ligament usually resists, and an oblique fracture of the fibula two to four inches from its lower end results.

*Clinical Features.*—In a considerable proportion of cases—in our experience in the majority—this fracture is not accompanied by any marked deformity of the foot, and the patient is often able to walk after the injury with only a slight limp.



Fig. 209.—Pott's Fracture of Left Ankle with marked deformity.

In others, however, the deformity is marked and characteristic (Figs. 208 and 209). The foot is everted, its inner side resting on the ground. The internal malleolus is unduly prominent,

stretching the skin, which may give way if the patient attempts to walk. The foot having lost the support of the malleoli, is often displaced backward, and the toes are pointed by the contraction of the calf muscles. There is abnormal mobility—both lateral and antero-posterior—and crepitus may be elicited. The points of tenderness are over the internal lateral ligament or internal malleolus, according to which is damaged; the inferior tibio-fibular joint, and at the seat of fracture of the fibula. Distal pressure over the shaft of the fibula, or on the extreme tip of



Fig. 210.—Ambulant Splint of Plaster-of-Paris.

the malleolus, may elicit pain and crepitus at the seat of fracture. There is usually considerable ecchymosis and swelling in the hollows below and behind the malleoli; and the malleoli appear to be nearer the level of the sole. In Dupuytren's fracture, when the astragalus passes up between the tibia and fibula, there is great broadening of the ankle.

There is often considerable difficulty in distinguishing a *sprain* of the ankle from a fracture without displacement, as both forms of injury result from the same kinds of violence, and are rapidly followed by swelling and discoloration of the overlying soft parts. In a sprain, the point of maximum tenderness is over the ligaments that have been damaged, whereas

in fracture, the site of the break is the most tender spot. The X-rays are often useful in the diagnosis of doubtful cases.

*Treatment.*—In those cases of fracture of the lower end of the fibula in which there is no marked displacement,—and they constitute a considerable proportion,—the limb should be massaged and laid on a pillow between sand-bags, or placed in a box splint for two or three days, until the swelling subsides. Some form of rigid apparatus, such as lateral poroplastic splints fixed in position with an elastic bandage, which will allow the patient to get about with crutches, is then applied. This is removed daily to permit of massage and movement being carried out—a point of great practical importance, because if massage and movement be neglected, not only does union take place more slowly, but the persistent stiffness of the ankle and œdema of the leg and foot which ensue, prolong the period of the patient's incapacity and endanger the functional usefulness of the limb.

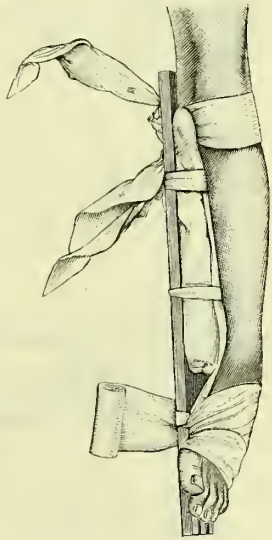


Fig. 211.—Dupuytren's Splint applied to correct eversion of foot.

It is in cases of this kind that the *ambulatory method* of treatment yields its best results. When, in the course of two or three days, the swelling has subsided, a plaster-of-Paris case (Fig. 210) is applied in such a way that when the patient walks the weight is transmitted from the tuberosities of the tibia through the plaster case to the ground, no weight being borne by the bones at the seat of fracture. The apparatus is applied as follows :—A boracic lint bandage is applied to the limb as far as the knee, and protecting pads or rings of wool are placed over the tuberosities of the tibia, the head of the fibula, and the malleoli. A pad of wool about three inches thick is then placed under the sole of the foot and fixed in position by a plaster-of-Paris bandage, which is carried up the limb in the usual way. The case is made specially strong on the sole, around the ankle, up the sides of the leg, and at the bearing-point at the head of the tibia. After the plaster has thoroughly set, the patient is allowed to walk about with a stick, crutches being unnecessary. In the course of three weeks the

plaster case may be removed and the limb massaged. It is usually found that the movements of the ankle are scarcely interfered with, and the patient is generally able to resume work within a month of the accident.

When there is marked eversion of the foot, it is sometimes necessary to reduce the deformity under chloroform, and if it tends to recur this may be prevented by *Dupuytren's splint* (Fig. 211). This splint, which is the same shape as Liston's long splint, but on a small scale, is applied to the inner side of the leg, extending from the knee to well beyond the sole of the foot. A large pad is placed in the hollow above the internal malleolus, and must be thick enough to carry the splint so far from the limb that when the foot is fully inverted it does not touch the splint. The upper end of the splint having been fixed to the leg at the level of the tuberosities of the tibia, a bandage is applied to correct the eversion of the foot, and at the same time to support the heel, and, as far as possible, to overcome the pointing of the toes. Care must be taken to avoid carrying the turns of this bandage over the seat of fracture. The limb may then be slung in a cradle, or placed on a pillow resting on its outer side with the knee flexed. In the course of a few days, a poroplastic or a Croft's splint may be substituted and massage commenced.

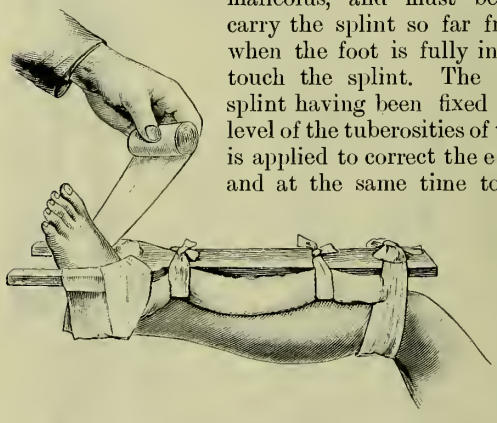


Fig. 212.—Syme's Horse-Shoe Splint applied to correct backward displacement of foot.

When backward displacement of the heel is the prominent deformity, *Syme's horse-shoe or stirrup splint* (Fig. 212) is sometimes employed. It is applied to the anterior aspect of the limb, which is carefully padded to prevent undue pressure on the edge of the shin bone. As the inner aspect of the leg slopes from the crest of the shin more abruptly than the outer, in order that the splint may have a flat surface to rest upon, the padding must be twice as thick on the inner as on the outer side. After the upper end of the splint has been fixed below the knee, the heel is pulled forward by a few turns of bandage passed over the prongs at the lower end of the splint. The foot is then

inverted and brought up to a right angle by a few supplementary turns of the bandage. In a few days this appliance may be replaced by a poroplastic or a Croft's splint.

Mal-union of Pott's fracture may necessitate an operation to restore the usefulness of the ankle. This consists in dividing the bone by means of an osteotome, forcibly inverting the foot, and then putting the limb up in the same way as a recent fracture.



Fig. 213. — Converse of Pott's Fracture. Man æt. 37. Blow on outer side of ankle. Tibia broken about two inches above top of internal malleolus. Tip of external malleolus chipped off.

**The Converse of Pott's Fracture — sometimes called "Pott's Fracture with Inversion."** — This injury is fairly common and results from forcible inversion of the foot. The external malleolus is broken across its base, or, in young subjects, along the epiphysial line. The internal malleolus alone may be carried away, or a portion of the broad part of the tibia may accompany it.

The foot is inverted, the heel falls back, and the toes are pointed (Fig. 213). In other respects it corresponds to the typical Pott's fracture, and is treated on the same principles. When Dupuytren's splint is required it is, of course, applied to the outer side of the leg.



Fig. 214.—Partial Separation of Lower Epiphysis of Left Tibia outward, in a boy æt. 16.

**Separation of the lower epiphysis of the tibia** is not very common. It occurs most frequently between the age of eleven and eighteen as a result of forcible eversion or inversion of the foot. It is usually accompanied by fracture of the diaphysis of the fibula, and is not infrequently compound. When displaced laterally, the deformity is very characteristic (Fig. 214). The growth of the tibia may be arrested, in which case the

continued growth of the fibula causes the foot to become inverted. The treatment is the same as for Pott's fracture.

**Fracture of the astragalus** may occur as a result of a fall from a height, the bone being crushed between the tibia and the os calcis. It is usually associated with other fractures, and its diagnosis is only to be made by exclusion, or by the use of the Röntgen rays. The fracture is sometimes impacted and the foot assumes the position of equino-varus. The most satisfactory treatment, especially in impacted fracture with persistent deformity, is complete excision of the bone—an operation which usually yields very good results. In interpreting radiograms of injuries in this region, care must be taken not to mistake the os trigonum tarsi for a fracture.

The **os calcis** is most frequently broken by the patient falling from a height, and landing on the sole of the foot, and the injury may occur simultaneously on both feet.

The primary fracture is usually longitudinal, passing through the facets for the astragalus and cuboid, and from this various secondary fissures radiate; the cancelled tissue is much crushed, so that the whole bone is flattened out. In spite of the great comminution it is often impossible to elicit crepitus, as the fragments are held together by the investing soft parts. In other cases the foot may feel like "a bag of bones." The lesion is often mistaken for a fracture of the lower end of the fibula, or is not diagnosed at all. The chief clinical feature is pain on movement of the foot, or on attempting to walk. The foot appears flat, and the hollows on either side of the tendo Achillis are filled up. In many cases there is a persistent tenderness in the foot which delays restoration of function for some months, but the ultimate result is usually satisfactory.

*Treatment.*—In simple comminuted fractures the patient should be anæsthetised, and the foot moulded into position, special care being taken to restore the arch in order to avoid any tendency to flat foot. The foot is supported on a pillow, and to prevent stiffness, massage and movements of the ankle and tarsal joints should be commenced within a few days.

Compound fractures confined to the os calcis may be treated on conservative lines, but if associated with other injuries of the foot they may necessitate amputation.

*Separation of the posterior tubercle*, into which the tendo Achillis is inserted, by forcible contraction of the calf muscles, may result from a misstep, or from a fall on the ball of the foot. The separated fragment may be pulled up for a distance of one

or two inches, and the rough surface from which it has been torn may be recognisable. The patient is often able to walk immediately after the accident, although with difficulty.

A good functional result is usually obtained by relaxing the calf muscles and fixing the foot in the position of extreme plantar flexion with the knee flexed, but in some cases it may be advisable to peg the fragments, either through the skin or after exposing them by incision.

The **other bones of the tarsus** are very rarely fractured separately.

**Fractures of the metatarsals and phalanges** usually result from direct violence, crushing the foot and severely damaging the soft parts. The use of the Röntgen rays has shown, however, that certain painful conditions in the foot following comparatively slight injuries, such as kicking a stone, or walking over frozen and uneven ground, are due to fractures of metatarsals or phalanges.

When simple, these injuries are often overlooked on account of the difficulty of eliciting the signs of fracture, owing to the swelling which accompanies them. They are best treated in a rigid moulded splint.

Compound fractures are more commonly met with, and are to be treated on the same principles as govern such injuries elsewhere.

*A fracture of the base of the fifth metatarsal* has been described by Jones, of Liverpool. It is produced by the patient coming down forcibly on the outer edge of the foot while the foot is inverted and the heel raised—as, for example, in dancing. There is a localised swelling over the base of the fifth metatarsal, and pain when the patient puts weight on the foot. There is no crepitus or deformity. The fracture is readily recognised by the Röntgen rays. Massage is employed from the first, and movement may be commenced at the end of a week.

## Dislocations in the Region of the Ankle.

**Dislocations of the Ankle-Joint.**—In describing dislocations of the astragalus from the tibio-fibular socket, the varieties are named according to the direction in which the foot passes—backward, forward, inward, outward, or upward.

All of them may be complete, but are more frequently incomplete, and they are all liable to become compound, either from tearing of the skin at the time of the injury, or by its

sloughing later. Although as a rule there is little difficulty in effecting reduction by manipulation, these injuries are liable to be followed by stiffness and impaired usefulness of the joint.

The *backward* dislocation is the most common, and results from extreme plantar flexion of the foot, wedging the astragalus between the tibia and fibula, as from a fall backwards while the foot is fixed. The lateral ligaments are torn, and one or both malleoli may be broken, or the posterior part of the articular edge of the tibia chipped off.



Fig. 215.—Ankylosis of Ankle after Compound Fracture with Lateral Dislocation of Ankle, and Pointing of the Toes.

(Specimen in Professor Annandale's collection.)

The foot appears shortened, the heel is unduly prominent behind, and the lower ends of the tibia and fibula project in front, sometimes coming through the skin. The tendons around the joint are stretched or torn.

*Forward* dislocation results from extreme dorsal flexion at the ankle-joint. The foot appears lengthened, the heel is less prominent than normal, and the hollows on each side of the tendo Achillis are obliterated. The astragalus is felt in front of the tibia, and the malleoli appear to be displaced backwards and towards the sole.

*Lateral* dislocations—inward or outward—are only possible after fracture of one or both malleoli, and may be looked upon as complications of these injuries (Fig. 215).

In cases where the interosseous ligament is ruptured, and in aggravated cases of Dupuytren's fracture, the astragalus may pass *upwards* between the bones of the leg. There is great broadening in the region of the ankle, and the malleoli are unduly prominent under the skin, which is tightly stretched over them. They are also nearer to the sole than normal. The movements of the ankle-joint are lost.

Dislocation of the *inferior tibio-fibular joint* is exceedingly rare, except in association with fractures of the lower ends of the bones of the leg, particularly Dupuytren's fracture, or with dislocation of the ankle-joint proper.

*Treatment.* — The patient having been anæsthetised, the foot is extended and the knee and hip joints flexed in order to relax the calf muscles as completely as possible. Traction is then made upon the foot, while counter-extension is applied to the leg, and the bones are manipulated into position. Reduction usually takes place gradually without the characteristic snap which accompanies reduction of most dislocations. It is sometimes necessary to divide the tendo Achillis, particularly in cases of forward dislocation.

When the astragalus passes upwards between the tibia and fibula, it is sometimes impossible to effect reduction by manipulation, and the best results are then obtained by excising the bone.

The after-treatment of dislocations of the ankle consists in



FIG. 216.—Compound Dislocation of the Astragalus.
(Dr. Wm. Stewart's case.)

keeping the leg on a pillow between sand-bags, and applying massage to the foot and ankle.

In compound dislocations which have become infected primary amputation may be indicated, but in young and healthy subjects an attempt should be made to save the foot.

**Dislocation of the astragalus** from its articulations with the bones of the leg above and the os calcis and scaphoid below, is a comparatively common injury, and results from a violent wrench of the foot. It may be incomplete or complete When the foot is plantar-flexed at the moment of injury the displacement is generally *forward* with a tendency outward. The astragalus comes to rest on the external cuneiform and cuboid bones, the foot being adducted, inverted, and displaced bodily inward. In a large proportion of cases the dislocation is compound, more or less of the astragalus being forced through the skin (Fig. 216).

When the foot is dorsiflexed at the moment of injury the

displacement is *backward*, but this is very rare, as are also *lateral dislocations*, and *dislocation by rotation*, in which the astragalus is rotated in its socket. In all these injuries the head of the astragalus loses its normal relationship with the malleoli.

*Treatment.*—An attempt should be made to reduce the dislocation under anæsthesia, the limb being placed in the same position as for reduction of dislocations of the ankle. While traction is made upon the foot, an assistant presses directly on the displaced bone and endeavours to manipulate it into position. In incomplete dislocations this usually succeeds, but it not infrequently fails in those which are complete, and in this case it may be necessary to chisel through the external malleolus to admit of reduction, or to excise the astragalus. In most cases of compound dislocation also the bone should be removed.

**Sub-astragaloid Dislocation.** — In this dislocation, which results from the same kinds of violence as the last, the astragalus retains its position in the tibio-fibular socket, and the os calcis and scaphoid, with the rest of the foot, are carried away from it. The head of the astragalus, therefore, maintains its normal relationship with the malleoli—a point of importance in the differential diagnosis between this injury and dislocation of the astragalus. The displacement is usually incomplete, and the foot may either pass backward and inward, or backward and outward. When the foot passes *backward and inward*, the head of the astragalus projects on the outer part of the dorsum, resting on the cuboid. The dorsum of the foot is shortened, the heel lengthened, the toes adducted, and the inner border of the foot raised. The external malleolus is unduly prominent, and reaches nearly to the sole.

In the *backward and outward* variety, the internal malleolus and head of the astragalus project unduly towards the inner side of the foot, which is abducted and everted.

In neither variety is there any mechanical obstacle to movement at the ankle-joint.

The *treatment* is carried out on the same lines as for dislocation of the astragalus, reduction being effected without difficulty in most cases. If this fails, as it occasionally does, it may be necessary to excise the astragalus.

**Medio-tarsal dislocation**—that is, at the astragalo-scaphoid and calcaneo-cuboid articulations—is extremely rare. The distal segment of the foot is usually displaced towards the sole; the foot is foreshortened, the malleoli raised from the sole, the arch of the foot is lost, and the first row of tarsal bones project on the dorsum. The treatment consists in reducing the displace-

ment by manipulation, after which massage and movement are employed.

**Tarso-metatarsal Dislocations.**—One, several, or all of the metatarsals may be separated from the distal row of tarsal bones —the usual cause being a fall from a horse, the foot being fixed in the stirrup. The bases of the metatarsal bones are displaced outward and toward the dorsum. Reduction by manipulation is generally easy.

**Dislocations of the Toes.**—The great toe may be dislocated at its metatarso-phalangeal joint, the base of the proximal phalanx passing outward and towards the dorsum. Diagnosis and reduction are alike easy.

**Inter-phalangeal** dislocations are very rare.

# CHAPTER XXVIII.

## DISEASES OF BONE.

Anatomy and physiology — Regeneration of bone — Transplantation of bone. Diseases of Bone—Definition of terms—Pyogenic diseases: *Acute osteomyelitis and periostitis; Chronic and relapsing osteomyelitis; Abscess of bone*—Tuberculous diseases—Syphilitic diseases —Hydatids; Rickets; Osteomalacia—Tumours of bone.

**Surgical Anatomy.**—During the period of growth a long bone, such as the tibia, consists of a shaft or *diaphysis*, and two extremities or *epiphyses*. So long as growth continues there intervenes between the shaft and each of the epiphyses a disc of actively growing cartilage—*the epiphysial cartilage*; and at the junction of this cartilage with the shaft is a zone of young, vascular, spongy bone known as the ossifying or *epiphysial junction*. The shaft is a cylinder of compact bone enclosing the medullary canal, which is filled with marrow. The extremities, which include the ossifying junctions, consist of spongy bone, the spaces of which are filled with marrow. The articular aspect of the epiphysis is invested with a thick layer of hyaline cartilage, known as the articular cartilage.

The external investment of the bone—the *periosteum*—is thick and vascular during the period of growth, but becomes thin and less vascular when the skeleton has attained maturity. Except where muscles are attached it is easily separated from the bone; at the extremities it is intimately connected with the epiphysial cartilage and with the epiphysis, and at the margin of the latter it becomes continuous with the capsular ligament of the adjacent joint. It consists of two layers, an outer fibrous and an inner cellular layer, the latter being concerned with the formation of new bone.

The arrangement of the blood-vessels determines to some extent the incidence of certain diseases of bone. The nutrient artery, after entering the medullary canal through a special foramen in the cortex, bifurcates, and one main division runs towards each of the extremities of the bone, and terminates at the ossifying junction in a series of capillary loops projected against the epiphysial cartilage. This arrangement of capillary loops favours the lodgment of any organisms which may be circulating in the blood, and partly accounts for the frequency with which diseases of bacterial origin develop in the region of the ossifying junction. The shaft of the bone is also nourished by numerous blood-vessels from the periosteum, which penetrate the cortex through

the Haversian canals and anastomose with those derived from the nutrient artery.

The epiphyses are nourished by a separate system of blood-vessels, derived chiefly from the arteries which supply the adjacent joint. The veins of the marrow are of large calibre and are devoid of valves. The nerves enter the marrow along with the arteries, and, being derived from the sympathetic system, are probably chiefly concerned with the innervation of the blood-vessels, but they are also capable of transmitting sensory impulses, as pain is a prominent feature of many bone affections.

The function of the periosteum is to form new bone. In diseased conditions the formation of new bone may be arrested, retarded, or exaggerated. In infantile paralysis the function of the periosteum is often in abeyance, and the bones are abnormally thin and smooth. Increase in the activity of the periosteum results in an addition to the thickness or girth of the bone. When the new bone is added in the shape of a uniform layer on the surface, the condition is spoken of as *hyperostosis*; when it assumes the form of spicules or irregular outgrowths, these are spoken of as *osteophytes*; and when it is heaped up so as to form a circumscribed elevation, this is described as a *node*.

The marrow, in addition to its blood-forming functions, is chiefly concerned in the absorption of bone which is in excess of physiological requirements. Under certain conditions—and especially from the prolonged irritation caused by pyogenic infection or by syphilis—the marrow assumes active bone-forming functions. This may lead to condensation of the spongy bone, and to diminution or obliteration of the medullary canal, whereby the bone becomes dense and heavy; to this condition the name *sclerosis* is applied. When the periosteum and marrow are simultaneously engaged in the formation of bone, a combination of hyperostosis and sclerosis results.

Under other conditions the absorption of lime salts and excavation of bone may be excessive, and the shaft may become soft and brittle; so that it is liable to bend under the weight of the body or to break from slight violence.

*Hypertrophy of bone* results where there is a physiological increase in the bone-forming functions of the periosteum or of the marrow, or of both combined, and *atrophy* when the formation of bone is retarded or arrested, or absorption is in excess of the normal. In the atrophy which accompanies old age, there is both diminished formation and excessive absorption of bone. Considerable interest attaches to that form met with in the neck of the femur, in which, while the bone retains its external form, there is excavation and enlargement of the marrow spaces at the expense of the osseous framework; this is sometimes described as eccentric atrophy.

The function of *the epiphysial cartilage* is to provide for the growth of the shaft in length. While all epiphysial cartilages contribute to this result, certain of them functionate more actively and for a longer period than others. Those at the knee contribute more to the length of the limb than do those at the hip or ankle, and they are also the last to unite. In the upper limb this arrangement is reversed, for the more active epiphyses are at the shoulder and wrist, and, like those at the knee, are also the last to unite.

The activity of the epiphysial cartilage may be modified as a result of disease. In rickets, for example, the formation of new bone may take place unequally, and may go on more rapidly in one half of the disc than in the other, with the result that the axis of the shaft comes

to deviate from the normal, as in knock-knee and bow-knee. In bacterial diseases originating in the marrow, if the epiphysial junction is directly involved in the destructive process, its bone-forming functions may be retarded or abolished, and the subsequent growth of the bone be seriously interfered with. On the other hand, if it is not directly involved, but is merely influenced by the proximity of an inflammatory process, its bone-forming functions may be stimulated and the growth of the bone in length exaggerated. In paralysed limbs the growth from the epiphyses, although sometimes retarded or arrested, is usually little short of the normal. The result of interference with growth is more injurious in the lower than in the upper limb, because, from the functional point of view, it is essential that the lower extremities should be approximately of equal length. In the forearm or leg, where there are two parallel bones, if the growth of one is arrested the continued growth of the other results in a deviation of the hand or foot to one side.

In certain constitutional diseases, such as rickets and inherited syphilis, dwarfing of the individual results when all the epiphyses have their activities retarded.

**Regeneration of Bone.**—When bone has been lost or destroyed as a result of injury or disease, it is capable of being reproduced, the extent to which regeneration takes place varying under different conditions. The chief part in the regeneration of bone is played by the periosteum, in virtue of the active functions possessed by the layer of osteoblasts on its deep surface. Provided the periosteum has been preserved, the whole shaft of a long bone may be reproduced after having been destroyed by disease or removed by operation. The reproductive capacity of the periosteum covering the epiphyses is usually more restricted. The periosteum of the flat bones of the skull and of the bones of the face, which are primarily developed in membrane, has very little capacity of forming new bone; hence, when bone has been lost or removed in these situations, there often results a permanent defect, even although the periosteum has been preserved.

The marrow plays a minor part in the regeneration of bone. It is chiefly of service in eating away or removing periosteal bone which is not permanently required, and in modelling the new bone according to architectural requirements.

Wounds or defects in articular cartilage are repaired chiefly by the formation of fibrous or osseous tissue.

*Transplantation of Bone—Bone-grafting.*—There is still difference of opinion as to the fate of portions of bone which have been removed from their native soil and implanted elsewhere, or reimplanted in the situation from which they were detached. According to Barth and others, the implanted portion of bone remains quite passive, like any other aseptic foreign body, such as ivory or calcined bone, and is gradually penetrated by the surrounding vessels and tissue elements, and finally replaced by new bone. Clinical experience is conclusive that a portion of bone which has been completely detached from its surroundings—for example, a trephine circle, or a flap of bone detached with the saw, or the loose fragments in a compound fracture—may unite if replaced in position, and may after an interval present a surface which is absolutely intact, while at its margins it is firmly and permanently incorporated with the surrounding bone. Embedded foreign bodies, on the other hand, such as ivory pegs or decalcified bone, exhibit, on removal after a sufficient interval, evidence in the

shape of worm-eaten depressions and perforations of having been eroded. In practice one may fill small defects with a flap of periosteum and bone taken from the tibia, the crest of the ileum, or from an amputated toe. When the shaft of a long bone, such as the humerus or femur, has been resected, the fibula from the same subject or the tibia from a recently amputated limb may be inserted into the gap.

Transplanted living bone retains its vitality, not only when embedded in bone-forming tissues, but also when embedded in the soft parts, as is evidenced by the result of operations in which bone has been transplanted to form a new bridge to the nose.

## DISEASES OF BONE.

The different morbid processes met with in bone originate in the same way and lead to the same general results as do similar processes in other tissues. The structural peculiarities of bone, however, and the important changes which take place in the skeleton during the period of growth modify certain of the clinical and pathological features.

Our conceptions of the nature of the diseases which affect the skeleton have been rendered clearer and more accurate by the demonstration of the bacterial origin of the great majority of them.

*Definition of Terms.*—Any inflammatory process which affects the periosteum is spoken of as *periostitis*; the term *osteomyelitis* is employed when the inflammation occurs in the marrow. In using these terms, however, it should be remembered that they indicate only the seat of the morbid process, but give no information regarding its nature. This is conveyed by prefixing such qualifying adjectives as pyogenic, tuberculous, or syphilitic to the terms periostitis or osteomyelitis. The term *ostitis* is intended to convey the idea of an inflammatory process in bone apart from periostitis or osteomyelitis; but it is doubtful if this ever occurs. The term *epiphysitis* has been applied to an inflammatory process in two distinct situations—namely, the ossifying nucleus in the epiphysis, and the ossifying junction between the epiphysial cartilage and the diaphysis. We shall restrict the term to inflammation in the first of these situations. Inflammation at the ossifying junction is included under the term osteomyelitis.

The term *rarefying ostitis* is applied to any inflammatory process which is attended with excessive absorption of the framework of a bone, whereby it becomes more porous or spongy than it was before, a condition known as *osteoporosis*. This is to be

regarded as an accompaniment or as a result of different diseased conditions, rather than as a separate entity.

The term *caries* is employed to indicate any diseased process associated with crumbling away of the framework of a bone. It may be considered as the equivalent of ulceration in soft parts. The carious process is always preceded by the formation of granulation tissue in the marrow or periosteum and the erosion of the bone in contact with it. The subsequent caseation or liquefaction of the granulation tissue results in destruction of the trabecular framework of the bone, whereby it is rendered soft and friable. Clinically, carious bone yields a soft grating sensation under the pressure of the probe. The student should regard caries, not as a disease in itself, but as a result of different diseases, and should therefore always add a qualifying adjective, such as suppurative, tuberculous, or syphilitic, which will indicate its nature.

The term *dry caries* (*caries sicca*) is applied to that variety which is unattended with suppuration; it is illustrated by the changes met with in the articular surfaces in certain forms of tuberculous disease of joints.

*Necrosis* is the term applied to the death of a tangible portion of bone, and the dead portion when separated is called a *sequestrum*. The term *exfoliation* is sometmies employed to indicate the separation or throwing off of a superficial sequestrum. Necrosis is regarded as the equivalent of sloughing or gangrene in soft parts, and, like caries, is to be looked upon as the result of disease and not as a disease in itself.

### Bacterial Diseases.

The most important diseases in this group are the pyogenic and the tuberculous. It is convenient also to include the lesions of syphilis, although the causal organism has not yet been conclusively demonstrated.

Pyogenic Diseases of Bone.—These diseases result from infection with pyogenic organisms, and are most commonly met with while the growth of the skeleton is in active progress. The organisms reach their seat of action in the bones by way of the blood-stream, having entered the circulation either from a pre-existing focus of disease in another part of the body, or through the skin or one of the mucous surfaces. In certain cases the infection takes place directly, either through a wound or from a contiguous area of disease. They include not only all the conditions which run an acute course and are attended with

the formation of pus, such as acute suppurative osteomyelitis, but also certain affections which run a more chronic course and are not associated with suppuration.

**Diseases caused by the Staphylococcus Aureus.**—As the majority of pyogenic diseases are due to infection with the staphylococcus aureus, these will be described first.

**Acute osteomyelitis** is a suppurative inflammation beginning in the marrow and tending to spread to the periosteum. The disease is common in children, but is rare after the skeleton has attained maturity. Males are affected more often than females, in the proportion of three to one, probably because they are more exposed to injury and to violent exertion.

*Etiology.*—Infection takes place in various ways. In some cases a possible source of infection through the skin exists in the form of eczema, acne pustules, small infected wounds, or septic conditions at the umbilicus. A mucous surface is perhaps a more frequent site of entrance of the cocci. Although proof of this is rarely obtainable, it is rendered probable by the frequency with which osteomyelitis is preceded by excoriations and fissures in the mouth and nose, by adenoids, small tonsillar abscesses, or by intestinal disturbances, such as diarrhœa. Staphylococci may enter the general circulation and be deposited in a living state in the marrow, without there being any immediate evidence of such infection, or only such minor disturbances of health as are indicated by slight indisposition or feverishness, and shooting "rheumatic" pains in the limbs. That they are capable of lying latent is evidenced by the fact that the disease may break out afresh after apparent cure.

Conditions causing congestion of the marrow, and so disturbing its nutrition, may act as localising factors in the production of osteomyelitis—as, for example, a blow or other form of injury, some extra exertion such as a long walk, or exposure to cold, as in wading.

The long tubular bones are affected in the following order of frequency: either end of the tibia; the lower end of the femur; the upper end of the humerus; the ulna, the fibula, the radius; the metatarsals, metacarpals, or phalanges. The other bones of the skeleton are only affected in rare instances.

*Pathology.*—As a rule, the disease commences and is most intense in the ossifying junction at one end of the bone, and primarily affects the marrow. It may commence at both ends simultaneously—bipolar osteomyelitis; or, commencing at one end, may spread to the other.

The changes observed in the marrow are those of intense

inflammation, gradually going on to purulent infiltration. Where the process is most advanced—that is, at the ossifying junction—there are evidences of absorption, rarefaction, and disappearance of the framework of the bone; the marrow spaces and Haversian canals are enlarged and filled with greenish-yellow pus. The cavities thus formed often communicate with the exterior by holes in the cortex, through which the pus may escape. The veins may become the seat of thrombosis and infective phlebitis.



Fig. 217. — Acute Suppurative Periostitis of Humerus, showing stripping of periosteum from upper part of diaphysis.

The inflammation affects chiefly the shaft of the bone, and necrosis of a considerable portion, or even of the entire shaft, takes place rapidly—hence the name "acute necrosis" formerly applied to the disease. Doubtless the vitality of the bone is seriously impaired by the vascular and tissue changes which attend the process, but the actual death is the result of the action of the toxins.

The process may remain localised to the ossifying junction, may spread along the medullary canal for a varying distance, or may extend through the cortex to the periosteum by way of the Haversian canals. It then presents the features of periosteal inflammation and suppuration, the pus accumulating under the periosteum and lifting it up from the bone (Fig. 217). The periosteum of the diaphysis is easily separated—hence the facility with which the pus spreads along the shaft; but in the region of the ossifying junction it is raised with difficulty, because of its intimate connection with the epiphysial cartilage. Less frequently there are several collections of pus under the periosteum, each being derived from a focus of suppuration in the subjacent marrow. When there is pus in the marrow there is nearly always pus under the periosteum, and the converse is usually true. The pus makes its way to the surface by the easiest anatomical route, and discharges externally, forming one or more sinuses. The pus may spread to the adjacent joint, either directly through the epiphysis and articular cartilage, or by burrowing under the periosteum and capsule. When the epiphysis is intra-articular as, for example, in the head of the femur, the pus infects the joint directly.

While the occurrence of purely periosteal suppuration is described by most authors, we are of opinion that the disease always originates in the marrow.

When there is marked absorption and destruction of bone at the ossifying junction, the epiphysis is liable to be separated. The separation—*epiphysiolysis*—usually takes place through the ossifying junction, and the surfaces of the diaphysis and epiphysis are opposed to each other by irregular eroded surfaces bathed with pus. The separated epiphysis may be maintained in contact with the diaphysis by the periosteum, but when this has been detached by the formation of pus beneath it, the epiphysis is liable to be displaced by muscular action or by some movement of the limb. Except in cases where the epiphysis is displaced, the epiphysial cartilage usually remains intact, and continues its bone-forming functions. Where it has been seriously damaged, however, the further growth of the bone in length may be interfered with. When intra-articular, as in the head of the femur, the whole epiphysis may die and separate as a sequestrum.

The adjacent joint may become filled with a serous effusion, which, on examination, is usually found to be sterile. When pus erupts into the joint, the lesion assumes the characters of a purulent arthritis, which, from its frequency during the earlier years of life, has been called *the acute arthritis of infants.*

In the small bones of the carpus and tarsus, the associated joints are usually infected from the outset. In flat bones, such as the skull, scapula, or ilium, suppuration may occur on both aspects of the bone.

*Clinical features.*—The constitutional symptoms, which are due to the associated toxæmia, vary considerably in different cases. In mild cases they may be so slight as to escape recognition ; in very severe cases the patient may succumb before there is any evidence of the localisation of the staphylococci in the bones. In average cases, the temperature rises rapidly with a rigor and runs an irregular course with morning remissions, there is marked general illness accompanied by headache, vomiting, and sometimes delirium and convulsions.

The first local manifestations are pain and tenderness in relation to one of the long bones ; the pain may be so severe as to prevent sleep and to cause the child to cry out ; tenderness on pressure enables one to identify the seat of the lesion, and is therefore of great diagnostic value. At a later stage there is swelling in the region of the ossifying junction, œdema, and dilatation of the superficial veins.

The swelling appears earlier and is more definite in superficial bones, such as the tibia, ulna, or clavicle, than in those more deeply placed, such as the upper end of the femur or humerus. It may be less evident to the eye than to the fingers, and is best appreciated by palpating the bone from the middle of its shaft towards its end. The maximum thickening and the tenderness usually correspond to the junction of the shaft with the epiphysis, and the swelling tails off gradually towards the diaphysis. As time goes on, there is diffuse redness of the skin, especially over a superficial bone, such as the tibia. The swelling becomes elastic and yielding, and gives definite evidence of fluctuation. This stage may be reached at the end of twenty-four hours, or not for some days.

Suppuration spreads towards the surface, until, at the end of several days, the swelling bursts and the pus escapes, after which the fever usually remits and the pain and other symptoms are relieved. The pus may contain blood and droplets of fat derived from the marrow, and in some cases minute particles of bone are present also. The presence of fat and bony particles in the pus confirms the medullary origin of the suppuration.

If an operation is performed, the periosteum is found to be raised from the bone, and the extent of the bare bone corresponds fairly accurately with the extent of the lesion in the marrow.

*Local Complications.* — The adjacent joint may exhibit symptoms which vary from those of a simple effusion to those of a purulent *arthritis.* The joint symptoms may account for little in the clinical picture, or may so predominate as to overshadow those of the bone lesion from which they originated.

*Displacement of the epiphysis* may take place insidiously, and reveal itself by an alteration in the attitude of the limb, which may resemble that of a dislocation; it is nearly always associated with suppuration in the adjacent joint.

When *pathological fracture* of the shaft occurs, as it may do, from some muscular effort or strain of the limb, it is attended with the usual signs of fracture.

*Pathological dislocation* has been chiefly observed at the hip, and it may or may not be associated with suppuration in the joint; it may result from effusion into the joint with stretching of the ligaments, or may be the sequel of a purulent arthritis. Cases are sometimes met with in which there is suppurative osteomyelitis in the femur on one side, and dislocation of the hip without suppuration on the other.

*General Complications.* — In some cases a *multiplicity of lesions* in the bones and joints imparts to the disease the features

of pyæmia. The occurrence of septic endocarditis, as indicated by alterations in the heart sounds and the development of murmurs, may cause widespread infective embolism, and metastatic suppuration in the internal organs as well as in the bones and joints. The secondary suppurations are liable to be overlooked unless carefully sought for, as they are rarely attended with much pain.

In these forms of osteomyelitis, the patient is dull and listless, or restless and talkative, or he is actually delirious. The tongue is dry and coated, the lips and teeth are covered with sordes, the motions are constipated, or they may be loose and offensive, and may be passed involuntarily. The temperature is remittent and very irregular, the pulse is small and rapid, and the urine is scanty and may contain blood and albumen. Sometimes the skin shows erythematous and purpuric rashes, bleeding takes place from the nose and mouth, bed-sores form over the sacrum, the belly becomes swollen and sensitive, and the patient may cry out as in meningitis.

*Differential Diagnosis.*—Acute osteomyelitis is to be diagnosed from erysipelas, cellulitis, and other inflammations of the soft parts, and in the case of the tibia, from erythema nodosum. Tenderness localised to the ossifying junction is one of the most valuable diagnostic signs of osteomyelitis.

When there is early and pronounced general intoxication, the severe forms of osteomyelitis are most likely to be confused with certain fevers, such as scarlet fever. In all febrile conditions in children and in young adults, the ossifying junctions of the long bones should be examined for areas of pain and tenderness.

Acute osteomyelitis has many features in common with rheumatic fever, and some authorities believe them to be different forms of the same disease (Kocher, Sahli). In acute rheumatism, however, the joint symptoms and signs predominate, there is an absence of suppuration, and pains and temperature yield to salicylates much more decidedly than in osteomyelitis.

The *prognosis* varies with the type of the disease, the initial severity and prominence of the symptoms of intoxication, with the seat of disease—the vertebræ, skull, pelvis, and lower jaw being specially unfavourable—with the multiplicity of the lesions, and with the development of septic endocarditis and internal metastases.

*Treatment.*—This is carried out on the same lines as in other suppurative diseases. The limb is wrapped in a moist dressing,

and laid on a pillow, while the necessary preparations for operative treatment are being made.

The most important indications are to let out the pus as early as possible, and to avoid introducing any fresh infection.

*Operative Treatment of Suppurative Osteomyelitis.*—The bone is exposed in the vicinity of its ossifying junction by an incision which affords the best access and inflicts least damage to the overlying soft parts. The periosteum is incised and the pus soaked up with gauze. Indications of the disease having originated in the marrow are often present, such as the presence of fat droplets or bone particles in the pus, the oozing of pus through holes in the cortex, or signs of commencing separation at the ossifying junction. The shell of the bone is perforated with a drill, gouge, or trephine. If pus is found, additional openings are made according to the extent of the disease in the marrow, and these may be finally converted into one open gutter. In view of the great vascularity of the tissues, the limb should be elevated to empty it of blood, and the circulation controlled by means of a rubber-band. The opening of the medullary canal not only tends to cut short the disease and prevent the occurrence of relapses, but diminishes the tendency to necrosis. We therefore recommend trephining the bone in the region of the ossifying junction, as a routine procedure in all cases of acute osteomyelitis.

When there is widespread suppuration in the marrow and the bone is extensively bared of periosteum and appears likely to die *en masse*, the shaft may be resected either at this stage or after an interval of two or three days. Resection of the shaft is also indicated if opening of the marrow is not followed by relief of symptoms; it is more often practised in osteomyelitis of the bones of the leg or forearm than in the femur or humerus.

Amputation of the limb is reserved for grave cases in which life is endangered from general intoxication. It may be called for later if the limb is useless, as, for example, when the whole shaft of the bone is dead without any formation of a new case, when epiphyses are displaced and the adjacent joints are disorganised.

Flat bones, such as the skull or ilium, must be trephined and the pus cleared out from both aspects of the bone. In the vertebræ, operative interference is usually restricted to opening and draining any associated abscess.

In cases which are left to nature those portions of the periosteum and marrow which have retained their vitality, resume their osteo-

genetic functions, often to an exaggerated degree. Where the periosteum has been lifted up from the shaft by an accumulation of pus, or is in contact with bone which is dead, it proceeds to form new bone with great activity, so that the dead shaft becomes surrounded by a sheath or case of new bone, known as the *involucrum* (Fig. 218). Where the periosteum has been perforated by pus making its way to the surface, there are defects or holes in the involucrum, called *cloacæ*. As these correspond more or less in position to the sinuses in the skin, in passing a probe down one of the sinuses it usually passes through a cloaca and strikes the dead bone lying in the interior. If the periosteum has been extensively destroyed, new bone may only be formed in small patches here and there, or not at all. The tissue cells and capillary loops on the internal aspect of the new case form a lining of granulations which, if in immediate contact with the dying bone, eat into its surface and partly absorb it. The bone in process of separation thus acquires a pitted, grooved, or worm-eaten appearance, and undergoes diminution in size. If the periosteal surface of the bone is bathed in pus, it remains smooth and intact. The separation of the dead bone from the living is effected by granulation tissue aided by osteoclasts, which eat into the living as well as into the dead bone, so that separation takes place at the expense of both. Ultimately the dead bone becomes loose and forms a sequestrum which usually presents an eroded or worm-eaten appearance. The sequestrum is usually white, but may be discoloured by the products of decomposition. The separation of the sequestrum in the vicinity of the ossifying junction takes place more rapidly than in the compact bone of the shaft.



Fig. 218.—Shaft of the Tibia after Acute Osteomyelitis. The shaft of the bone has undergone extensive necrosis, and a shell of new bone has been formed by the periosteum.

(Specimen originally figured by James Syme in his *Principles of Surgery* and now in Mr. Annandale's collection.)

When foci of suppuration have been scattered up and

down the medullary cavity, and the bone has died in patches, several sequestra may be included by the new case. Each portion of dead bone is slowly separated, and comes to lie in a cavity lined by granulations.

As a result of formation of new bone by the marrow, the medullary canal may be obliterated, and the bone becomes heavier and denser—sclerosis. Wherever the periosteum has not been detached, the new bone which it forms is deposited on the original shaft, and results in an increase in the girth of the bone—hyperostosis.



Fig. 219.—Large Sequestrum of Lower Part of Shaft of Femur partly surrounded by New Bone; the latter is bent as a result of fracture which took place 2½ years before amputation.

(Museum, Royal College of Surgeons, Edinburgh.)

*Pathological fracture* of the shaft may occur at the site of necrosis, when the new case is incapable of resisting any strain put upon it, and is most frequently met with in the shaft of the femur. Short of fracture, there may be bending or curving of the new case, and this results in deformity and shortening of the limb (Fig. 219).

The extrusion of a sequestrum may occur, provided there is a cloaca large enough to allow of its escape, but the surgeon has usually to interfere by performing the operation of sequestrectomy. Displacement or partial extrusion of the dead bone may cause serious complications, as when a sequestrum derived from the trigone of the femur perforates the popliteal artery or the cavity of the knee-joint.

The extent to which bone which has been lost is reproduced varies in different parts of the skeleton: while the long bones of limbs, the scapula, the lower jaw, and other bones which are developed in cartilage are almost perfectly reproduced, the articular ends of bone, and bones which are entirely developed in membrane, such as the flat bones of the skull and upper jaw, are not reproduced at all.

*Sequelæ of Acute Suppurative Osteomyelitis.*—The patient may not apply for treatment until the acute stage has passed off and sinuses have formed. These sinuses have rigid edges which are usually depressed and adherent to the subjacent bone and generally imply the presence of a sequestrum.

In the pelvis, a sequestrum has been known to make its way into the bladder, and give rise to the symptoms of stone.

The *deformities* resulting from acute osteomyelitis are more marked the earlier in life the disease occurs. *Shortening* is not uncommon from interference with growth at the ossifying junction. *Exaggerated growth* in the length of a bone is rare, and has been observed chiefly in the bones of the leg. Where there are two parallel bones—as in the leg, for example—the growth of the diseased bone may be impaired, and the other continuing its normal growth becomes disproportionately long. Less frequently the growth of the diseased bone is exaggerated, and it becomes the longer of the two. In either case, the longer bone becomes curved. An *obliquity* of the bone may result when one half of the epiphysial cartilage is destroyed, and the other half continues to form bone, and this gives rise to such deformities as knock-knee and club-hand.

Deformity may also result from vicious union of a pathological fracture, permanent displacement of an epiphysis, contracture, ankylosis, or dislocation of the adjacent joint.

*The Recognition and Removal of Sequestra.*—So long as dead bone remains in position, there will be suppuration from the granulations lining the cavity in which it lies, and a discharge of pus from the sinuses.

The dead bone may be evident to the eye, but it is usually only recognised on passing a probe down a sinus. It is not easy from such examination to determine the size, character, or number of the sequestra, or to be certain that they are loose, but these points may be cleared up by examination with the X-rays.

The traditional practice is to wait until the dead bone is entirely separated before undertaking any operation for its removal, for fear, on the one hand, of leaving portions behind which may afterwards die, or, on the other, of removing more bone than is absolutely necessary. In our opinion this practice need no longer be rigidly adhered to, as by operating at an earlier stage healing is greatly hastened. If it is decided to wait for separation of the dead bone, drainage should be improved and the septic element combated.

*The operation* for the removal of the dead bone (*sequestrectomy*) consists in opening up the periosteum and the new case to a degree sufficient to allow of the removal of all the dead bone, including the most minute sequestra, and infected granulation tissue. The limb having been rendered bloodless, existing sinuses are enlarged, but if these are inconveniently situated—

for example, in the centre of the popliteal space in necrosis of the femoral trigone—it is better to make a fresh wound down to the bone on that aspect of the limb which affords the best access, and which entails the least injury of the overlying soft parts. The periosteum, which is thick and easily separable, is raised from the new case with an elevator, and by means of the chisel or gouge enough of the newly formed bone is taken away to allow of the removal of the sequestrum. Care must be taken not to leave behind any fragment of dead bone, as this will interfere with healing, or may determine a relapse of suppuration at a later period.

The dead bone having been removed, the lining granulations are scraped away with a sharp spoon, and the cavity is disinfected.

There are different ways of dealing with a bone cavity. It may be packed with iodoform gauze, which is changed at intervals until healing takes place from the bottom; it may be filled with a flap of bone and periosteum raised from the vicinity, or with bone grafts; or the wall of bone on one side of the cavity may be chiselled through at its base, so that it can be brought into contact with the opposite wall. Mention may also be made of the method of filling bone cavities devised by Mosetig-Moorhof. After the cavity has been disinfected and dried by a current of hot air, a mixture of powdered iodoform (60 parts), and oil of sesame and spermaceti (each 40 parts), which is fluid at a temperature of 112° F., is poured into the cavity and allowed to solidify; the soft parts are then brought together without drainage. As the cavity fills up with new bone, the iodoform is gradually absorbed.

Such procedures may be carried out at the same time as the sequestrum is removed, or after an interval.

**Serous or Albuminous Osteomyelitis and Periostitis.**—This is a mild and localised form of the disease due to an attenuated virus, and accompanied by an effusion of serous fluid under the periosteum, but with no tendency to pass on to suppuration or to produce necrosis.

**Growth fever** is to be regarded as another attenuated form of osteomyelitis which results in an exaggerated growth in length of the bones affected. It is probably the explanation of the condition popularly known as "growing pains," and in the lower limbs of children and adolescents is often mistaken for rheumatism.

The milder cases are not attended with fever, the child complains of vague evanescent pains and of feeling tired, and is disinclined to go about.

In the more severe forms the child is evidently ill, is weary

and disinclined to get up, has pains in the head and in the region of the joints of the limbs, and in the evening the temperature may rise considerably. The illness may be sudden and acute, and may last for two or three days, or may be milder and more prolonged, and there may be several relapses within twelve months.

The treatment consists in improving the general health, and during the persistence of the pains the child is kept at rest with the affected limb immobilised.

**Relapsing Osteomyelitis.**—As the term indicates, the various forms of relapsing osteomyelitis all date back to an antecedent attack, and their occurrence depends on the capacity of staphylococci to lie latent in the marrow for long periods.

Relapse may take place within a few months of the original attack or not for many years, and there may be repeated outbreaks. Cases are sometimes met with in which outbreaks recur at regular intervals for several years, the tendency, however, being for the attacks to become milder and milder as the virulence of the organisms becomes attenuated. Osteomyelitis in a patient over twenty-five is usually of the relapsing variety.

*Clinical Features.*—In some cases the bone becomes enlarged, and the patient complains of pain and tenderness on pressure; in others there are the usual phenomena which attend suppuration, but the pus is slow in coming to the surface, and the constitutional symptoms are slight. The pus may escape by new channels or one of the old sinuses may reopen. If a sequestrum forms it is usually walled in by new bone and difficult to discover.

*Treatment.*—In cases of hyperostosis and sclerosis with persistent and severe pain, if relief is not afforded by the repeated application of blisters, the thickened periosteum should be incised, and the bone opened up with the chisel or trephine. In cases attended with suppuration, the swelling is incised and drained, and if there is a sequestrum, it should be removed.

**Circumscribed Abscess of Bone—"Brodie's Abscess."**—The most important form of relapsing osteomyelitis is the circumscribed abscess of bone described first by Benjamin Brodie. It is usually met with in young adults. Several years may intervene between the original attack of osteomyelitis and the onset of symptoms of abscess.

*Morbid Anatomy.*[1]—The abscess is nearly always situated in

[1] Alexis Thomson, *Edin. Med. Journ.*, 1906.

the central axis of the bone in the region of the ossifying junction, although cases are occasionally met with in which it lies nearer the middle of the shaft. In exceptional cases there is more than one abscess. The tibia is the bone most commonly affected, but the lower end of the femur, or either end of the humerus, is frequently the seat of an abscess. In the quiescent stage the lesion is represented by a small cavity in the bone, filled with clear serum, and lined by a fibrous membrane which is engaged in forming new bone. Around the cavity the bone is sclerosed and the medullary canal may be obliterated. When the process goes on to the formation of an abscess, the contents of the cavity are transformed into a greenish-yellow pus from which the staphylococcus can be isolated, and the cavity is lined by a thin film of granulation tissue, which erodes the surrounding bone and so causes the abscess to increase in size. If the erosion proceeds uniformly the cavity is spherical or oval, if it is more active at some points diverticula or tunnels are formed, and one of these may finally erupt through the shell of the bone on a periosteal surface or into an adjacent joint. Small irregular sequestra are occasionally found within the abscess cavity. In long-standing cases it is common to find extensive obliteration of the medullary canal, and an increase in the girth of the bone from new formation by the periosteum.



FIG. 220. — Enlargement of Upper End of Tibia from an Abscess in the Interior. The cavity was large enough to contain 16½ ounces of fluid.

(Museum of Royal College of Surgeons, Edinburgh.)

The size of the abscess ranges from that of a cherry to that of a walnut, but specimens found in museums show that if left to nature, the abscess may attain much greater dimensions (Fig. 220.)

The affected bone is not only thicker and heavier than normal, but may also be curved or otherwise deformed.

The *clinical features* are almost exclusively local. Pain, due to tension within the abscess, is the dominant symptom. At first it is vague and difficult to localise, later it is referred to the interior of the bone and is described as "boring." It is aggravated by using the limb, and there are often, especially during the night, exacerbations in which the pain becomes

excruciating. In the early stages there are remissions of days or weeks, during which the symptoms entirely disappear, but as the abscess increases these become shorter and shorter until the patient is hardly ever free from pain. Localised tenderness can almost always be elicited by percussion or by pressing the bone between the fingers and thumb. The pain induced by the traction of muscles attached to the affected bone, or by the strain of the weight of the body, may interfere with the function of the limb, and in the lower extremity cause a limp in walking. Disability may be due to involvement of the adjacent joint, in which there may be an intermittent hydrops which comes and goes coincidently with exacerbations of pain; or the abscess may perforate into the joint and set up an acute arthritis.

The differential *diagnosis* of Brodie's abscess, from other affections met with at the ends of long bones, and particularly from tuberculosis, syphilis, and new growths, is made by a consideration of the previous history of the patient, especially with reference to an antecedent attack of osteomyelitis and of the clinical evidence. Recourse, however, should always be had to an examination with the X-rays. In a considerable number of cases there is an ill-defined light area in the centre of a dark shadow at the level of the lesion; but if the zone of sclerosis around the abscess is well marked this light area is wanting and a uniform dark shadow is cast, which of itself is usually sufficient to exclude a central gumma or new growth. When the adjacent joint is implicated, the surgeon may be misled by the patient referring his symptoms to the joint rather than to the bone.

*Treatment.*—If an abscess is suspected, there should be no hesitation in exploring the interior of the bone. It is exposed by a suitable incision, and the periosteum reflected, the bone opened up by a trephine or chisel, and the presence of an abscess may be at once indicated by the escape of pus. If, owing to the small size of the abscess or the density of the bone surrounding it, the pus is not reached by this procedure the bone should be drilled in different directions. The pus and any dead bone having been cleared out, the cavity is scraped and disinfected, and packed with iodoform worsted.

**Osteomyelitis which is Chronic from the Outset.**—That there is a chronic form of pyogenic osteomyclitis has only been recognised within recent years. Formerly it was confused with syphilis and tubercle, and without bacteriological examination it is difficult to differentiate between these affections. Like relapsing osteomyelitis, it may assume the form of hyperostosis

and sclerosis, of suppurative osteomyelitis with or without necrosis, or of chronic abscess of bone.

*Necrosis without suppuration*, described by Paget under the name "quiet necrosis," is a rare disease, and would appear to be associated with an attenuated form of staphylococcal infection (Tavel). It occurs in adults, being met with up to the age of fifty or sixty, and it is characterised by the insidious development of a swelling, involving a considerable extent of a long bone. The pain varies in intensity, and may be continuous or intermittent, and there is tenderness on pressure. The shaft of the bone is increased in girth, as a result of its being surrounded by a new case derived from the periosteum. The resemblance to sarcoma may be very close, but the swelling is not as defined as in sarcoma, nor does it ever assume the characteristic "leg of mutton" shape. In both diseases there is a tendency to pathological fracture. It is difficult also to differentiate the condition from syphilitic and from tuberculous disease. If the diagnosis is not established after examination with the X-rays, it should be completed by an exploratory operation. If dead bone is found it is removed in the same way as in necrosis following acute osteomyelitis.

**Osteomyelitis due to Pyogenic Infections other than the Staphylococcus Aureus.**—In the forms of osteomyelitis above described, the infection is almost always due to the staphylococcus aureus, but other organisms having pyogenic properties may give rise to similar affections. The staphylococcus albus, the streptococcus pyogenes, and the pneumococcus, for example, sometimes cause osteomyelitis, particularly in young subjects, but the disease is, as a rule, of a milder type than that caused by the staphylococcus aureus, is attended with less profuse suppuration, and is not so liable to be followed by necrosis. In the streptococcal and pneumococcal forms the adjacent joint is not infrequently affected.

The *Typhoid Bacillus.*—In typhoid fever the bone marrow is markedly congested, and is liable to be invaded by bacilli which may set up osteomyelitis soon after their lodgment, or may lie latent for a considerable period before doing so. The lesions in the bones may be single or multiple, they may involve the marrow or the periosteum or both, and they may or may not be attended with suppuration. They are most commonly met with in the tibia and in the ribs at the costo-chondral junctions.

The bone lesions usually occur during the seventh or eighth week of the fever. The chief complaint is of vague pains, at

first referred to several bones, later becoming localised in one; they are aggravated by movement, or by handling the bone, and are worst at night. There is redness and œdema of the overlying soft parts, and swelling with vague fluctuation over the bone, and on incision there escapes a yellow creamy pus, or a brown syrupy fluid containing the typhoid bacillus in pure culture. Necrosis is exceptional.

When the abscess develops very slowly, the condition may resemble tuberculous disease of the bone, from which it may be diagnosed by the history of typhoid, and bacteriological examination of the pus.

The prognosis is favourable, but recovery is apt to be slow, and relapse is not uncommon.

It is usually sufficient to incise the periosteum, but when the disease occurs in the ribs it may be necessary to resect portions of these bones.



Fig. 221.—New Periosteal Bone on Surface of Femur from Amputation Stump. Osteomyelitis supervened on the amputation and resulted in necrosis at the sawn section of the bone.

(Anatomical Museum of University of Edinburgh.)

**Pyogenic Diseases of Bone due to Spread of Infection from the Soft Parts.**—There still remain for discussion those forms of osteomyelitis which result from direct infection through a wound involving the bone—for example, compound fractures, gun-shot injuries, osteotomies, amputations, resections, or operations for un-united fracture. In all of these the marrow is exposed to infection by such organisms as may be present in the wound. A similar form of osteomyelitis may occur apart from a wound, for example, in the case of the jaws the infection may spread to the bone from lesions of the mouth; in the skull, from lesions of the scalp or of the cranial bones themselves—such as a syphilitic gumma or a sarcoma which has fungated externally; and in the case of the petrous temporal, from suppuration in the middle ear.

The lesions included in this group have become much rarer since the introduction of Listerian surgery; in former times the disease was commonly met with as is evidenced by the

number of specimens in museums; those in the collection of the University of Edinburgh were derived chiefly from the wars in the Peninsula. The most common is an osteomyelitis which commences in the marrow exposed in the wound, and this presents the changes which characterise ordinary suppurative inflammation. In the case of amputation stumps, fungating granulations may protrude from the sawn end of the bone, and if necrosis takes place, the sequestrum is annular, affecting the cross section of the bone at the saw-line; or tubular, extending up the shaft, and tapering off above. The periosteum is more easily detached, is thicker than normal, and is usually actively engaged in forming new bone. In the macerated specimen, the new bone presents a characteristic coral-like appearance, and may be perforated by cloacæ (Figs. 221, 222).



FIG. 222. — Sequestrum of Femur, due to osteomyelitis following amputation.

Like other septic infections, it may terminate in pyæmia, as a result of septic phlebitis in the marrow.

The *clinical features* of osteomyelitis *in an amputation stump* are those of ordinary pyogenic infection; the bone lesion does not impart to them any special characters, and it may not even be recognised unless the bone affected is exposed to view. Healing does not take place until the sequestrum is thrown off or removed.

*In compound fractures*, if a fragment dies and forms a sequestrum, it is apt to be walled in by new bone, and the sinuses which result may continue to discharge until the sequestrum is removed. Even after healing has taken place, relapse is liable to occur, especially in gun-shot injuries. Months or years afterwards, either without apparent cause or after some extra strain of the limb or exposure to cold and wet, the bone may become painful and tender. The symptoms may subside under rest and elevation of the limb and the application of an antiseptic compress, or an abscess may form and burst with comparatively little suffering. The contents may be clear yellow serum or a watery pus; sometimes a small spicule of bone may be discharged.

## Tuberculous Diseases.

The tuberculous diseases of bone result from infection of the marrow or periosteum by tubercle bacilli conveyed through the arteries. It is exceedingly rare for tubercle to appear in bone as a primary infection, the bacilli being usually derived from some pre-existing focus in the bronchial glands or elsewhere. These diseases are characterised by their insidious onset and slow progress, and by the frequency with which they are associated with tuberculous disease of the adjacent joint. The association of bone and joint disease is explained by the tendency which tubercle has to attack the articular extremities of long bones and the marrow of short bones—for example, those of the carpus or tarsus. Volkmann, König, and Watson Cheyne should be mentioned as among those who have contributed most to our knowledge of the tuberculous diseases of bone.

**Tuberculous Periostitis** is met with in the ribs, sternum, spinal column, skull, and less frequently in the long bones of the limbs. It may originate in the periosteum or may spread thence from the marrow.

*In superficial bones*, such as the sternum, the formation of tuberculous granulation tissue in the deeper layer of the periosteum, and its subsequent caseation and liquefaction, is attended by the insidious development of a doughy swelling in relation to the bone, which is not as a rule painful, although tender on pressure. While the swelling may remain for some time without change, it eventually increases in size, becomes boggy or fluctuating, and assumes the characters of a cold abscess. The pus perforates the fibrous layer of the periosteum, invading and infecting the overlying soft parts, its spread being influenced by the anatomical arrangement of the tissues. The size of the abscess affords no indication of the extent of the bone lesion from which it originates. As the abscess reaches the surface, the skin becomes of a dusky red or livid colour, is gradually thinned out, and finally gives way, forming a sinus. A probe passed into the sinus strikes carious bone. The sinus persists as long as any active tubercle remains in the tissues, and unless protected by suitable dressings, forms an avenue for infection by pyogenic organisms, which favour the spread of the disease both in the bone and in the overlying soft parts. Small superficial sequestra of compact bone may sometimes be found embedded in the granulation tissue formed in relation to the periosteum.

*In deeply seated bones*, such as the upper end of the femur,

the formation of a cold abscess in the soft parts is often the first evidence of tuberculous disease in the periosteum, and its true source and nature may only be recognised on incising the abscess and exploring its interior.

*Diagnosis.*—Before the stage of cold abscess is reached, the localised swelling over the bone is to be differentiated from a syphilitic gumma, from chronic forms of staphylococcal osteomyelitis, from certain forms of enlarged bursa or of ganglion, especially in the region of the knee, from subperiosteal lipoma, and from sarcoma. Most difficulty may be met with in relation to periosteal sarcoma, which, however, is characterised by its rapid and continuous progress, by the severity and persistence of pain in spite of rest, and by the absence of suppuration. A rise of temperature in the evening is more likely to be present in cases of rapidly growing sarcoma than in tubercle, unless the latter is complicated with pyogenic infection or with phthisis. The X-rays, in the case of tubercle, show a superficial erosion of the bone, while in sarcoma there is usually a considerable formation of new bony material. The final appeal is to exploratory incision, and to histological and bacteriological examination of the diseased tissue.



Fig. 223.—Enlargement of Lower End of Humerus and Upper End of Ulna, the result of tuberculous osteomyelitis. The term spina ventosa is applicable to the condition of the upper end of the ulna.

(Museum of Royal College of Surgeons, Edinburgh.)

The early recognition and prompt treatment of periosteal tuberculosis in the region of the articular ends of long bones is of importance, as the disease, when left to itself, is liable to spread to the adjacent joint.

*Treatment* may be carried out by the injection of iodoform, or by open incision and removal of the infected tissues with the sharp spoon. In the case of the ribs it is more satisfactory to remove the diseased portion of bone. If all the tubercle has been removed and the skin is healthy, the wound may be stitched up

with the object of obtaining primary union; otherwise it is treated by the open method.

**Tuberculous Osteomyelitis.** — Tuberculous lesions in the marrow occur as isolated or multiple foci of tuberculous granulation tissue, which replaces the marrow and eats away the trabeculæ of bone in its vicinity. If the process spreads in the marrow as a diffuse caseous infiltration, death of bone on a considerable scale may ensue, giving rise to sequestra. When these involve an articular surface they are usually wedge-shaped (Fig. 270); in other situations they are rounded or irregular. When the death of bone is preceded by sclerosis, the sequestrum is denser than normal bone. Finally, the sequestrum lies loose in a cavity lined by tuberculous granulation tissue. In diffuse lesions of the shaft of a long bone, the continued absorption of bone in the interior, while new bone is laid down by the periosteum, results in an expansion of the bone to which the name *spina ventosa* was formerly applied (Fig. 223).



Fig. 224.—The Metatarsal and Phalangeal Bones of a Great Toe, showing destructive changes in tuberculous dactylitis.

(From Mr. Annandale's collection.)

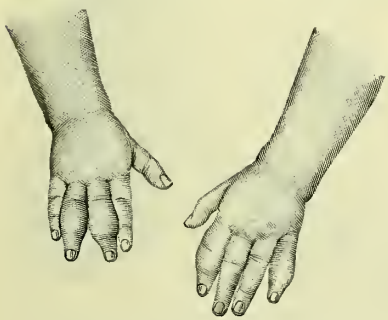


Fig. 225.—Tuberculous Dactylitis.

(Photograph lent by Mr. Stiles.)

*Clinical Features.* — As a rule it is only in superficially placed bones such as the tibia, ulna, clavicle, lower jaw, or phalanges, that tuberculous disease in the marrow gives rise to signs sufficiently definite to allow of its clinical recognition. In the vertebræ, or in the constituent bones of deeply seated joints, such as the hip or shoulder, the existence of tuberculous lesions in the marrow may only be inferred from indirect signs—such, for example, as rigidity and curvature in the case of the spine, or from the symptoms of grave and persistent joint-disease in the case of the hip or shoulder.

With few exceptions, tuberculous disease in the interior of a bone does not reveal its presence until by extension it reaches one or other of the surfaces of the bone. In the shafts of long bones its eruption on the periosteal surface is usually followed by the formation of a cold abscess in the overlying soft parts. When situated in the articular ends of bones, the disease more often erupts in relation to the reflection of the synovial membrane or directly on the articular surface—in either case giving rise to disease of the joint (Fig. 245).

**Diffuse tuberculous osteomyelitis of the shaft of a long bone** is comparatively rare, and has been observed chiefly in the tibia and in the ulna in children. There is a progressive enlargement of the bone without much pain, tenderness, or disturbance of function, and examination with the X-rays shows considerable new formation by the periosteum, while the bone bounding the medullary canal has to a large extent disappeared. The diagnosis for pyogenic or syphilitic disease in the marrow and from new growths is usually difficult, and may not be established until an exploratory operation is performed. If the interior of the bone is occupied by tuberculous material, this is cleared out by means of the sharp spoon, or the affected portion of the shaft is resected subperiosteally.



FIG. 226.—Tuberculous Dactylitis.

*In cancellous bones, such as those of the tarsus*, there is caseous infiltration of the marrow, and this is often attended with the formation of sequestra either in the interior of the bone or involving its outer shell as shown in Fig. 228. The situation and extent of the disease are usually to be recognised in X-ray photographs. After the tuberculous granulation tissue erupts through the cortex of the bone, it gives rise to a cold abscess or infects adjacent joints and tendon sheaths.

If an exact diagnosis is made at an early stage of the disease, and this is often possible with the aid of X-rays, the affected bone is completely excised, or its interior is cleared out with the sharp spoon and gouge, the latter procedure being preferred in the case of the *os calcis*. When several bones and joints are simultaneously affected, and there are sinuses

with mixed infection, amputation is usually indicated, especially in adults.

**Tuberculous dactylitis** is the name applied to a diffuse form of tuberculous osteomyelitis of phalanges, metacarpal or metatarsal bones. The macerated bone may present the appearance of having been expanded — the *spina ventosa* of earlier writers — due to the replacement of the original bone by granulation tissue and the continuous formation of new bone by the periosteum. In some cases the shaft of the bone dies, in part or in its entirety, and constitutes a sequestrum.

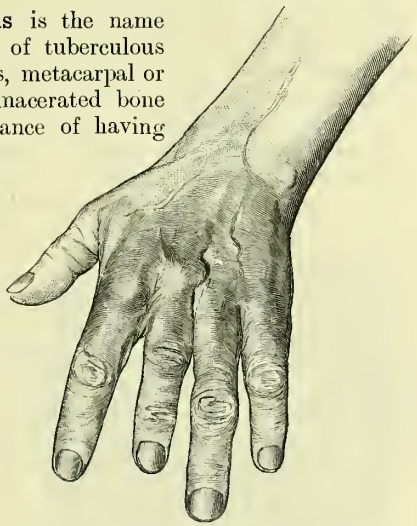


FIG. 227.—Shortening of Middle Finger of Adult, the result of tuberculous dactylitis in childhood.

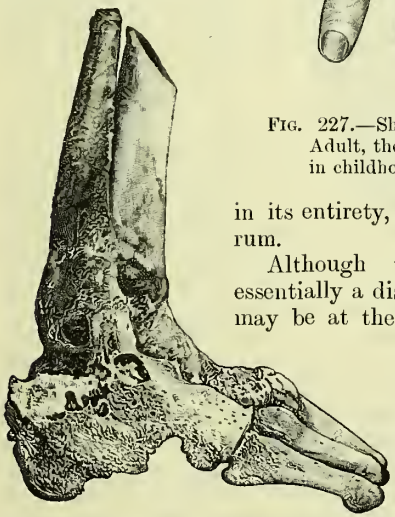


FIG. 228.—Advanced Tuberculous Disease in region of Ankle. The ankle-joint is ankylosed, and there is a large sequestrum in the os calcis.

(Specimen in Anatomical Museum, University of Edinburgh.)

Although tuberculous dactylitis is essentially a disease of the marrow, there may be at the same time disease in the periosteum.

The *clinical features* are those of a spindle-shaped swelling of a finger or toe, indolent, painless, and interfering but little with its functions. Recovery may eventually occur without suppuration, but in untreated cases it is very common to have the formation of a cold abscess, which bursts and forms one or more sinuses. Previous to abscess

formation it may be difficult to differentiate tuberculous dactylitis from the enlargement of the fingers in inherited syphilis (syphilitic dactylitis), especially when the tuberculous lesion occurs in a child who is the subject of inherited syphilis. In the syphilitic lesion, skiagrams usually show a more abundant formation of new bone, but in many cases the doubt is only cleared up by observing the progress of the case and the effects of anti-syphilitic treatment.

*Treatment.*—Recovery under conservative measures is not uncommon, and the functional results are usually much better than those following upon operative treatment, although in either case the affected finger is liable to be dwarfed (Fig. 227). The fingers should be immobilised in a splint, and the general health improved in every possible way. Operative interference is indicated if a cold abscess forms, if there is a persistent sinus, or if a sequestrum has formed, a point upon which information is obtained by examination with the X-rays. When the disease affects the toes, amputation should be recommended, but it is rarely called for in the fingers unless the disease is threatening to spread along the lymphatics, or is affecting the general health. It is more often required in adults than in children.

## Syphilitic Diseases of Bone.

Syphilitic diseases of bone may be met with at any period subsequent to the original infection. The graver forms are met with chiefly in the tertiary stage of acquired and inherited syphilis. The virus is carried by the blood-stream to all parts of the skeleton, but the actual development of the disease appears to be influenced by some local predisposition on the part of individual bones, and by external factors such as injury.

Syphilitic diseases of bone are much less frequently met with in practice than those due to pyogenic and tuberculous infections. They show a marked predilection for certain bones, notably the tibia, sternum and skull. They differ from tuberculous affections in the frequency with which they affect the shafts of long bones rather than the articular ends, and the consequent rarity of joint complications.

*Evanescent periostitis* is met with in acquired syphilis during the period of the early skin eruptions. The patient complains, especially at night, of pains over the frontal bone, ribs, sternum, tibiæ, and ulnæ. Localised tenderness is elicited on making pressure over the bone, and there is slight swelling of the periosteum, which rarely amounts to what may be described as a periosteal node.

In the later stages of acquired syphilis, *gummatous periostitis and osteomyelitis* are met with. These affections are characterised by the formation in the periosteum or marrow of a circumscribed gumma or of a diffuse gummatous infiltration. The framework of the bone is rarefied in the area immediately involved, and condensed in the parts beyond. If the gummatous tissue degenerates and breaks down, and especially if the overlying skin is perforated and septic infection is superadded, the bone disintegrates and exhibits the condition known as *syphilitic caries*; sometimes a portion of bone has its blood-supply so far interfered with by the gummatous tissue that it dies—*syphilitic necrosis*. Syphilitic sequestra are heavier and denser than normal bone because sclerosis often precedes necrosis, and they usually separate very slowly. The bones specially affected by gummatous disease are: the skull, the septum of the nose, nasal bones, palate, femur, tibia, and the bones of the forearm.

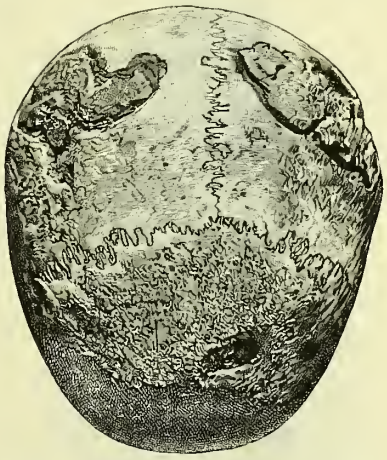


FIG. 229.—Syphilitic Disease of Skull, showing areas of necrosis in process of separation.

(In Mr. Annandale's collection.)

*In the bones of the skull*, gummata may form in the pericranium, diploë, or dura mater. An isolated gumma produces a characteristic depression or an actual perforation of the calvaria. Multiple gummata tend to fuse with each other at their margins, giving the appearance of a combination of circles; these sometimes surround an area of bone and cut it off from its blood-supply (Fig. 229). If the overlying skin is destroyed and septic infection superadded, such an isolated area of bone is apt to die and furnish a sequestrum; the separation of the dead bone is extremely slow, partly from the want of vascularity in the sclerosed bone round about, and partly from the density of the sequestrum. In exceptional cases the necrosis involves the entire vertical plate of the frontal bone. There is suppuration between the bone and the dura (suppurative

pachymeningitis), and this may be followed by brain abscess or by pyæmia.

On the inner aspect of the skull, a gumma forms a firm elastic swelling shading off into the surrounding bone. If it softens and perforates the skin, a sinus forms and mixed infection ensues, and this may be followed by necrosis of the skull and by meningitis or brain abscess and by pyæmia. Gummatous



Fig. 230.—Gummatous Disease of Tibia in girl æt. 20, the subject of inherited syphilis.

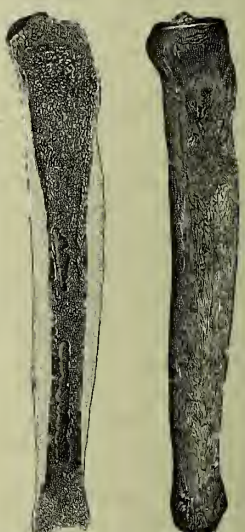


Fig. 231.—Syphilitic Hyperostosis and Sclerosis of Tibia.

disease in the wall of the orbit may cause protrusion of the eye and paralysis of the ocular muscles.

On the inner surface of the skull, the formation of gummatous tissue may cause pressure on the brain and give rise to intense pain in the head, Jacksonian epilepsy, or paralysis, the symptoms varying with the seat and extent of the gumma. At the base of the skull the cranial nerves may be pressed upon, especially at their points of exit, with symptoms of irritation or paralysis in the area of distribution of the nerves affected.

*In the septum of the nose, the nasal bones, and the hard palate*, gummatous disease in the periosteum causes ulceration, which, beginning in the mucous membrane, spreads to the bones, and

being complicated with septic infection leads to caries and necrosis. In the nose the disease is attended with stinking discharge (ozœna), the extrusion of portions of dead bone, and subsequently with deformity characterised by loss of the bridge of the nose; in the palate, it is common to have a perforation through which the air escapes into the nose in speaking.

*Syphilitic disease of the tibia* may be taken as the type of the affection as it occurs *in the long bones.* Gummatous disease in the periosteum may result in the formation of a well-defined node, or the whole shaft may become the seat of an irregular nodular enlargement (Fig. 230). If the bone is macerated it is found to be heavier and bulkier than normal; there is diffuse sclerosis which may cause obliteration of the medullary canal, and the surface is uneven from heaping up of new bone by the periosteum — hyperostosis (Fig. 231). If a periostcal gumma after breaking down spreads towards and invades the skin, a syphilitic ulcer with carious bone at the bottom results (Fig. 232). A central gumma may eat away the surrounding bone so that it readily undergoes pathological fracture. In the rare cases in which it attacks the articular ends of the long bones, gummatous disease may implicate the adjacent joint and give rise to syphilitic arthritis.

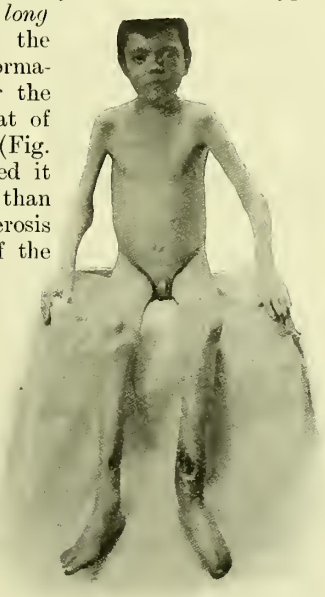


Fig. 232.—Gummatous Disease of Tibiæ in a boy æt. 10, the subject of inherited syphilis. There is a small gummatous ulcer just above left wrist, and an unbroken gumma in region of right elbow.

*Clinical Features.*—The pains in the bones are much more intense than during the secondary period, and are described as boring—as if a gimlet were being driven into the bone. They are worst at night, sometimes preventing sleep, and have been ascribed to the compression of the nerves as they pass through the narrowed Haversian canals.

The *periosteal gumma* appears as a smooth circumscribed swelling which is soft and elastic in the centre and firm at the

margins, and which gradually shades off into the surrounding bone. The swelling may disappear entirely or may give place to a densely hard node. In some cases the gumma softens in the centre, the skin becomes adherent, thin and red, and finally gives way. The opening in the skin may persist as a sinus, or may develop into the typical syphilitic ulcer with irregular, crescentic margins; in either case a probe reveals the presence of carious bone or of a sequestrum. The general health may be impaired as a result of superadded pyogenic infection and the absorption of toxins, and waxy degeneration in the viscera may ultimately be induced.

A *central gumma* in a long bone may not reveal its presence until it erupts through the shell of the bone and reaches the periosteal surface or invades an adjacent joint. Sometimes the first manifestation is a fracture of the bone produced by slight violence.

In radiograms the appearances of bones which are the seat of syphilitic disease are often characteristic. When there is hyperostosis and sclerosis, the shadow of the shaft of the bone is denser and broader than normal and the contour is uneven or wavy. When there is a central gumma, the shadow is intercepted by a rounded clear area.

*Diagnosis.*—The conditions most liable to be mistaken for syphilitic disease of bone are chronic staphylococcal osteomyelitis, tuberculosis, and sarcoma; and the diagnosis is to be made by the history and progress of the disease, the results of examination with the X-rays, and the effects of specific medicines.

*Treatment.*—In all cases the general health is to be improved by open air, by nourishing food, and by the administration of cod-liver oil, iron, and arsenic. Anti-syphilitic remedies should be given a thorough trial, and if they are administered before there is any destruction of tissue, the benefit derived from them is usually very decided. In certain cases, and particularly when there are destructive changes in the bone complicated with septic infection, specific remedies have little effect. In cases of persistent or relapsing gummatous disease with ulceration of skin, it is often necessary to remove the diseased soft parts with the sharp spoon and scissors, and to gouge or chisel away the unhealthy bone on the same lines as in tuberculous disease. Where hyperostosis and sclerosis of the bone is attended with severe pain which does not yield to blistering, the periosteum may be incised and the sclerosed bone perforated with a drill, gouge, or trephine.

When gummatous disease in the nose or palate persists

and threatens to result in deformity, the affected tissues may be removed by operation.

**Lesions of the Bones in Inherited Syphilis.**—Syphilis affects the bones more frequently in the inherited than in the acquired form of the disease. The lesions in infancy—epiphysitis, bossing of the skull, and craniotabes—have been described in the chapter on inherited syphilis (p. 180).

The lesions met with later correspond to those of the tertiary period of the acquired disease. Inasmuch, however, as they affect bones which are still actively growing, they may interfere with the growth of the bones in length. Gummatous disease may come and go over periods of many years, with the result that the external appearances and architectural arrangement of a long bone may be profoundly altered. In the tibia, for example, the bone may be flattened laterally so that the anterior edge is sharp and narrow; or the shaft may be thickened and lengthened and curved forwards—an appearance known as the "sabre-blade" deformity.

*Treatment* is carried out on lines similar to those recommended in the acquired disease. In view of the comparative inefficacy of iodides in inherited syphilis, most benefit results from measures directed to improving the general health. When curving of the tibia causes disability in standing and walking, the bone may be straightened by a cuneiform resection.

*Syphilitic dactylitis* is a characteristic lesion which is met with chiefly in children. It may affect any of the fingers, toes, metacarpals, or metatarsals, but is commonest in the first phalanx of the index-finger or of the thumb. Several fingers and toes may be attacked at the same time or in succession. The lesion consists in a gummatous infiltration of the soft parts surrounding the phalanx, or may take the form of a gummatous osteomyelitis, or these conditions may be combined.

The segment of finger affected becomes the seat of a swelling which is more evident on the dorsal aspect, and according to the distribution and extent of the disease it is acorn-shaped, fusiform, or cylindrical. It is firm and elastic, and but slightly painful or tender. The movements of the finger are impaired, especially if the joints are involved. In its early stages the disease is amenable to anti-syphilitic treatment, and may recover completely.

If untreated, the degenerated gummatous tissue approaches the surface, the skin over it becomes thin and purple and gives way, often on the lateral aspect of the finger, forming a sinus. The disintegrated bone may crumble away and the debris escape

in the discharge; the formation of a visible sequestrum is exceptional. Shortening and deformity of the finger follow when the bone is destroyed. The differential diagnosis from tuberculous dactylitis has been described with that disease (p. 604). Chondroma of the phalanges is recognised by the hardness and definition of the tumour, and by the appearances seen with the X-rays.

### Hydatid Disease of Bone.

This rare disease in bone has been studied chiefly by Gangolphe in France and by Targett in this country. It results from the lodgment of the embryos of the tænia echinococcus, which are conveyed to the marrow by the blood-stream. In contrast to what is observed in hydatids of internal organs such as the liver, the cysts in bone are small, usually about the size of a pin-head, and they are present in enormous numbers diffusely scattered throughout the marrow. The formation of brood capsules and of scolices is exceptional, and hooklets are rarely found. The parts of the skeleton most often affected are the articular ends of the long bones, the bodies of the vertebræ, and the bones of the pelvis.

As the cysts in the marrow increase in number and in size, the framework of the bone is gradually absorbed, and there result excavations or cavities which contain the hydatids. The marrow and spongy bone first disappear, the compact tissue then becomes thin and perforated, and pathological fracture may result. The bone gradually becomes expanded, and the cysts may escape through perforations into the surrounding cellular tissue, and when thus freed from confinement may attain considerable dimensions. Suppuration from superadded pyogenic infection is a frequent complication, and it may be attended with extensive necrosis, and lead to disorganisation of the adjacent joint.

*Clinical Features.*—The patient complains, over a long period, of deep-seated pains; which, however, are never so severe as in a Brodie's abscess. In superficial bones, such as the tibia, there is obvious enlargement, and it may be possible to recognise egg-shell crackling, or unequal consistence of the bone, it being hard in some parts, and doughy and elastic in others. The disease may pursue an indolent course during months or years until some complication occurs, such as fracture or suppuration. With the occurrence of suppuration the disease becomes more active, and abscesses may form in the overlying soft parts and in the adjacent joint. In the vertebral column hydatids give rise

to angular deformity and paraplegia. In the pelvis there is usually great enlargement of the bones, and when suppuration occurs it is apt to infect the hip-joint and to terminate fatally.

Examination with the X-rays shows the characteristic excavations of the bone caused by the cysts. The disease is liable to be mistaken for central tumour, gumma, tuberculosis, or abscess of bone.

The *treatment* consists in thorough eradication of the parasite by operation. The bone is laid open and scraped or resected according to the extent of the disease. In advanced cases complicated with spontaneous fracture or with suppuration, amputation affords the best chance of recovery.

The lesions in the bones resulting from *actinomycosis* and from *mycetoma* have been described with these diseases (p. 133).

## TROPHIC DISEASES OF BONE.

These include rickets, scurvy-rickets, osteomalacia, ostitis deformans, fragilitas ossium, and certain lesions met with in diseases of the nervous system.

### Rickets.

Rickets or rachitis is a constitutional disease associated with disturbance of the nutrition, and attended with characteristic changes in the skeleton. The disease is most common and most severe among the children of the poorer classes in large cities, who are improperly fed and are brought up in unhealthy surroundings. There is evidence that the most important factor in the causation of rickets is the administration of food which is deficient in animal fat, proteids, and salts of lime, or which contains these in such a form that they are not readily assimilated. The occurrence of the disease is favoured, and its features are exaggerated, by imperfect oxygenation of the blood as the result of a deficiency of fresh air and sunlight, and by other conditions which tend to lower the general health.

*Pathological Anatomy.*—The bone lesions are of considerable surgical importance. The most striking feature is the softness (malacia) of the bones due to the excessive absorption of osseous tissue and the formation of an imperfectly calcified tissue at the various sites of ossification. The affected portions of the skeleton lose their rigidity, so that the bones bend under the weight of the body, from the traction of muscles, and under the influence of other mechanical forces.

The *periosteum* is abnormally thick and vascular, and when detached carries with it plates and spicules of soft porous bone. The new bone deposited by the periosteum may be so abundant that it forms a thick crust on the surface, and in the flat bones of the skull this may be heaped up in the form of bosses or ridges resembling those met with in inherited syphilis.

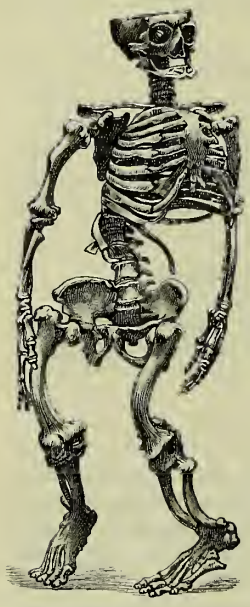


FIG. 233.—Skeleton of Rickety Dwarf. The skeleton is that of "Bowed Joseph," leader of the meal riots in Edinburgh, who died in 1780.

(Anatomical Museum, University of Edinburgh.)

In the epiphysial cartilages and at the ossifying junctions, all the processes concerned in ossification, excepting the deposition of lime salts, occur to an exaggerated degree. The cartilage of the epiphysial disc proliferates actively and irregularly so that it becomes softer, thicker, and wider, and gives rise to a visible swelling, best seen at the lower end of the radius and lower end of the tibia, and at the costo-chondral junctions, where the series of beaded swellings is known as the "rickety rosary."

The ossifying zone is increased in depth; the marrow is abnormally vascular; and any new bone which is formed is imperfectly calcified. The result is that the affected bones may never attain their normal length, and they remain stunted throughout life as in rickety dwarfs (Fig. 233), or the shafts of the long bones may grow unequally and come to deviate from their normal axes, as in knock-knee and bow-knee. Areas of overgrown cartilage may persist as islands surrounded by bone or marrow, and, according to Virchow, may subsequently become the starting-point of cartilaginous tumours.

The changes in the *marrow* consist chiefly in an exaggeration of the normal process of absorption of bone. In the shafts of the long bones the cortex becomes porous and yielding, and the spongy bone is rarefied or disappears; hence the bones readily bend or break under mechanical influences. When the disease is recovered from, a process of repair sets in which often results in the affected bones becoming denser and heavier than normal. In the flat bones of the skull the absorption may

result in the entire disappearance of areas of bone, leaving a membrane which dimples like thin cardboard under the pressure of the finger—a condition known as *craniotabes.*

*Changes in the Skeleton as a Whole.*—The distribution and nature of the changes in the skeleton vary widely in different cases, being influenced by the period of onset, the severity and duration of the disease, and the conditions under which the child is placed.

*In Children before they are able to walk.*—The fontanelles and sutures of the *skull* remain open until the end of the second year or longer, and the frontal and parietal eminences are unduly prominent. There is sometimes hydrocephalus, and the whole head is characteristically enlarged. The jaws are altered so that while the upper jaw is contracted into the shape of a V, the lower jaw is square instead of rounded, and when the teeth erupt they do not oppose one another. In the *thorax* the chief feature may be the beading at the costo-chondral junctions, especially of the fifth and sixth ribs, or its walls may be contracted, especially if the respiration is interfered with as a result of bronchial catarrh or adenoids. The contraction may take the form of a vertical groove on each side, or of a horizontal groove at the level of the upper end of the xiphisternum; when the sternum and cartilages form a projection in front the deformity is known as "pigeon-breast."

The *spine* may be curved backwards—*kyphosis*—throughout its whole extent or only in one part of the column; or it may be curved to one or other side—*scoliosis.*

In the *limbs*, the prominent features are the deficient growth in length of the long bones, the enlargements at the epiphysial junctions, and the bending, and occasional greenstick fracture, of the shafts. At this stage the curves depend on the attitude of the child while sitting or being carried—for example, the arm bones become bent in children who paddle about the floor with the aid of their arms; and in a child who lies on its back with the lower limbs everted, the weight of the limb may lead to curvature of the neck of the femur—coxa vara. The clavicle or humerus may sustain greenstick fracture from the child being lifted by the arms; the femur by a fall. From the extreme laxity of the ligaments, the joints can be moved beyond the normal limits, and the child is often observed to twist its limbs into abnormal attitudes.

*In Children who are able to walk.*—In these children the most important deformities met with occur in the spine, pelvis, and lower extremities, and result for the most part from

yielding of the softened bones under the weight of the body. Scoliosis is the usual type of spinal curvature, and in extreme cases it may lead to a pronounced form of hump-back. The pelvis may simply remain small (*justa-minor pelvis*), or it may be contracted in the sagittal plane (*flat pelvis*); when the bones are unusually soft, the acetabular portions are pushed inwards by the femora bearing the weight of the body, and the pelvis assumes the shape of a trefoil, as in the malacia of adult women. In the lower extremities the shaft of the femur is curved forwards and outwards; the bones of the leg outwards as in bow-leg (Fig. 289), or forwards, or forwards and outwards just above the ankle. The deformities at the knee (genu valgum, genu varum, and genu recurvatum), and at the hip (coxa vara), will be described with deformities.

*Clinical Features.*—Although rickets may be met with at or soon after birth, it is usually not until the child is three or four months old that the disease manifests itself, and sometimes not until the second year. The mother notices that the child perspires excessively during sleep, especially about the head, it is restless and throws off the clothes, is disinclined to be moved, and cries unless very gently handled. Its muscles become soft and flabby, and it is liable to attacks of diarrhœa and of bronchial catarrh. Dentition is delayed, and the teeth are apt to appear in the wrong order. The child is late in learning to walk. On examination there is no difficulty in recognising the changes in the skeleton which have already been described. The cranium is oftenest affected in young infants; the spine, thorax, and arms in those a little older; and the lower extremities in children in whom the disease has developed comparatively late. The abdomen is prominent, partly from flatulent distension of the bowels, partly from downward displacement of the liver which is sometimes enlarged, and from weakness of the belly walls; it appears larger from contrast with the contracted chest. The spleen may be enlarged. The weakness of the muscles of the trunk and limbs may be so pronounced as to excite the suspicion of a lesion of the spinal cord; and there may be an increased excitability of the central nervous system, shown by the occurrence of laryngismus stridulus or of general convulsions.

Rickety children present little resistance to infective diseases, and readily succumb, especially to pulmonary and intestinal tuberculosis. The progress of the disease is slow and intermittent, and varies with the age of the child, its surroundings, and the treatment employed; it may pass off in a few weeks, or may drag on for months or even years.

The majority of rickety patients seen in surgical practice suffer rather from the deformities resulting from rickets than from the disease itself. The examination of a large series of children at different ages shows that the deformities become less and less frequent with each year. Those who recover may ultimately show no traces of rickets, and this is especially true of children who grow at the average rate ; in those, however, in whom growth is retarded, especially from the fifth to the seventh year, the deformities are apt to become permanent. It may be noted that scoliosis of rickety origin has little tendency towards recovery.

*Treatment.*—The treatment of the disease consists in regulating the diet, improving the surroundings of the patient, and preventing deformity. In the first instance it may be necessary to attend to the stomach and bowels. Fresh air and sunshine are recommended, with precautions against catching cold. A change to the seaside, and the use of salt-water baths, followed by massage, are of great value. Phosphorus in doses of 100th grain may be given dissolved in cod-liver oil, and preparations of iron and lime may be added with advantage. In order to avoid those postures which predispose to deformities the child should lie as much as possible. In the well-to-do classes this is readily achieved by the aid of a nurse and the use of a perambulator. In hospital outpatients the child is kept off its feet by the use of a light wooden splint applied to the outer aspect of each lower extremity and extending from the pelvis to six inches beyond the sole. Splints and apparatus which admit of the child walking are not to be recommended.

When deformities have already developed, the treatment depends upon whether or not there is any prospect of spontaneous recovery. Under five years of age recovery may, as a rule, be confidently expected. The child should be kept off its feet, and the limbs bathed and massaged. In children of five or six and upwards the prospect of natural recovery is a diminishing one, and the more satisfactory means of correcting the deformity is by operation. In rickety curvature of the spine, the child should lie on a firm mattress, or, to allow of its being taken into the open air, upon a double Thomas' splint extending from the occiput to the heels ; the muscles acting on the trunk should be braced up by massage and appropriate exercises.

**Late Rickets, Malacia of Puberty,** or **Rachitis Adolescentium** is met with at any age from nine to seventeen, and is generally believed to be due to a recrudescence of rickets which had been present in early childhood. The disease is not attended with any disturbance of the general health, and is local, the patho-

logical changes being confined to the ossifying junctions, specially affecting those which are most active during adolescence—for example, at the knee-joint. It may play an important part in the production of certain deformities which occur at or near puberty—especially genu valgum, genu varum, and coxa vara —and it may be indirectly concerned in the production of such deformities as scoliosis and flat foot.

**Scurvy-Rickets, Hæmorrhagic Rickets.**—This disease, described by Barlow and Cheadle, is usually regarded as a combination of rickets and scurvy, although, according to Ashby, the hæmorrhagic element is the result of anæmia. It is met with in infants under two years who have been brought up upon sterilised or condensed milk and other proprietary foods, and is most common in the well-to-do classes. It is characterised by anæmia, severe pains in the bones, and extravasations of blood in relation to the muscles and the skin which appear on the surface as bruises. Fractures and separation of epiphyses attended with sub-periosteal hæmorrhage may occur from trivial injuries, chiefly in the bones of the thigh or leg. When a fracture takes place, the infant ceases to move the limb and screams if it is touched, and an excessively tender swelling may be recognised in the region of the epiphysis or adjacent part of the shaft; the skin becomes tense and shiny, and there may be crepitus. The disease in the bone may be mistaken for one or other of the pyogenic bone affections or for an ordinary fracture.

The *treatment* consists in correcting the errors in diet. The infant should have a wet nurse or a plentiful supply of cow's milk in its natural state. Anti-scorbutics in the form of orange, lemon, or grape juice, and of potatoes bruised down in milk may be given. Under this treatment marked improvement usually takes place within a few days, the hæmorrhages cease, and the extravasated blood is gradually reabsorbed. The rachitic element is treated on the lines already described (p. 615), and the injuries to the bones on general principles.

**Osteomalacia.**—The term osteomalacia includes a group of conditions in which the bones become soft and yielding, so that they are unduly liable to bend or break.

Next to the form which is associated with *rickets* which has already been described, *the osteomalacia of pregnant and puerperal women* is the commonest and best-known member of this group. It is met with chiefly in women of the poorer classes who bear children under unhealthy conditions. It is more common in those parts of South Germany bordering on the Rhine and in certain parts of Italy, than in this country. While

it may occur during a first pregnancy, it is oftener met with in multiparous women. It is usually confined to the pelvis and lumbar vertebræ, but in extreme cases may involve the entire skeleton.

The essential feature is the absorption of lime salts from the affected bones; the bone matrix, thus decalcified, disappears in its turn, so that the bones may be bent by the weight of the body or by the traction of muscles. After death they are so soft that they may be cut with a knife or squeezed like a sponge. In the progressive stage of the disease the marrow becomes very vascular, loses its fat, and is converted into a gelatinous tissue variously coloured with blood pigment derived from hæmorrhages into the marrow, which sometimes result in the formation of cysts filled with brown or yellow fluid. In extreme cases, the shafts of the long bones come to resemble membranous tubes which may be bent or twisted in any direction.

The cause of the disease is unknown; it has been suggested that it is the result of an affection of the central nervous system, probably beginning in the nerve cells of the anterior cornua of the cord.

Clinically, the patient complains of shooting pains in the lower part of the back, weakness of the lower limbs, and of inability to sit up. The bones may be tender on pressure, and the knee jerks are usually increased. When the spinal column is affected the vertebræ become compressed, and the patient may lose a foot or more in height within a few weeks. There may be a peculiar waddling gait from curving of the neck of the femur on both sides, and inability to flex the thigh and lift the foot from the ground. If recovery ensues, new bone replaces that which has been lost, the bones regain their rigidity, but the existing deformities persist.

The diagnosis is only difficult in the early stage of mild cases, in which the marked weakness of the lower extremities and exaggeration of the knee jerks may suggest a resemblance to certain diseases of the spinal cord. The bones do not give the usual dark shadow when examined with the Röntgen rays.

*Treatment.*—Measures directed towards improving the general health should be employed. The administration of phosphorus dissolved in cod-liver oil is generally recommended. Removal of the ovaries, as suggested by Fehling in 1886, has been followed by the relief of symptoms and arrest of the progress of the disease. For a description of the changes in the pelvis and their relation to pregnancy and parturition the student is referred to text-books on midwifery.

*Neuropathic Forms of Osteomalacia.*—In certain chronic diseases of the brain and cord, changes in the skeleton of the nature of osteomalacia may be met with. It is at present unknown why in certain cases the bones may lose their lime salts and bend, while in others they become porous and brittle. The senile form of osteomalacia also is apparently of nerve origin.

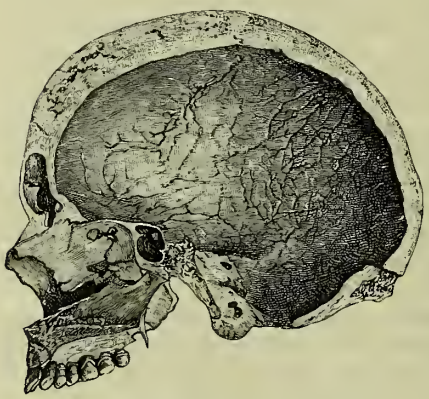


FIG. 234.—Changes in the Skull resulting from Ostitis Deformans.

(Anatomical Museum, University of Edinburgh.)

*Osteomalacia associated with New Growths in the Skeleton.*—Recklinghausen and others have described cases in which the marrow is transformed into a white fibrous tissue which may be the seat of hæmorrhages and cysts along with the development of giant-celled tumours or myelomata scattered throughout the skeleton. This condition is usually associated with multiple fractures. There is also a form of osteomalacia associated with secondary cancer when this is widely diffused throughout the skeleton.

**Ostitis Deformans—Paget's Disease of Bone.**—This rare



FIG. 235.—Cadaver, illustrating the alterations in the Lower Limbs resulting from Ostitis Deformans.

disease was first described by Sir James Paget in 1877. In the early stages, the marrow is transformed into a vascular connective tissue; its bone-eating functions are exaggerated, and the framework of the bone becomes rarefied, so that it bends under pressure as in osteomalacia. In course of time, however, new bone is formed in great abundance both by the periosteum and by the marrow; it is at first devoid of lime salts, but later

becomes calcified, so that the bones regain their rigidity. This formation of new bone is much in excess of the normal, the bones become large and bulky, their surfaces rough and uneven, their texture sclerosed in parts, and the medullary canal in the long bones is frequently obliterated. These changes are well brought out in X-ray photographs. The curving of the long bones, which is such a striking feature of the disease, may be associated with actual lengthening, and the changes are usually remarkably symmetrical (Fig. 235). The bones forming the cranium may be enormously thickened, the distinction into tables and diploë is lost, and, while the general texture is finely porous, there may be areas of bone as dense as ivory (Fig. 234).

*Clinical Features.*—The disease affects persons over fifty years of age of either sex, and develops very gradually without any discoverable cause. The patient's attention may be first attracted by the occurrence of vague pains in the back or limbs; by the obvious enlargement and bending of such bones as the tibia or femur; or by a gradual increase in size of the head, necessitating the wearing of larger and larger hats. When the condition is fully developed the attitude and general appearance are eminently characteristic. The height is diminished, and, owing to the curving of the lower limbs and spine, the arms appear unnaturally long; the head and upper part of the spine are bent forwards; the legs are held apart, slightly flexed at the knees, and are rotated out as well as curved; the whole appearance suggests that of one of the larger anthropoid apes. The muscles of the limbs may waste to such an extent as to leave the large, curved, misshapen bones covered only by the skin (Fig. 235).

The disease may last for an indefinite period, the general health remaining for long unaffected; the patient, however, finally succumbs to bronchitis or other intercurrent disease. In a considerable number of cases the bones become the seat of sarcoma.

No *treatment* is of any avail in arresting or curing the disease, and all that can be done is to relieve symptoms as they arise.

**Neuropathic Atrophy of Bone.**—The conditions included under this heading occur in association with diseases of the nervous system, but it is difficult to ascertain how far the changes in the skeleton are the result of altered trophic nerve influence, and how far they are the result of vaso-motor disturbances.

Among the clinical forms of neuropathic atrophy, most importance attaches to the fragility of the bones met with in

*locomotor ataxia* and other chronic diseases of the spinal cord. The bones become porous and brittle, with an excess of fatty marrow, so that they are liable to be fractured by forces which would be insufficient to break a healthy bone. The fragility affects especially the bones of the extremities, and may occur before there are any definite nerve symptoms, but it is more often met with in the ataxic stage, and the abrupt and uncontrolled movements may play a considerable part in the causation of the fractures. They may be unattended with pain, and they may fail to unite; when repair does take place it is sometimes attended with an excessive formation of callus. Joint lesions of the nature of Charcot's disease may occur simultaneously with the alterations in the bones. In *syringomyelia* pathological fracture is not so frequent as in locomotor ataxia; it is more likely to occur in the bones of the upper extremity, and especially in the humerus.

In paralytic dementia and other *chronic forms of insanity*, a similar porosity and brittleness of bones may be observed, and may result in pathological fracture, especially of the ribs or femur. In some cases of *epilepsy* the bones may be so brittle that they break when the patient falls in a fit, and the fracture is usually comminuted.

**Fragilitas Ossium**, or **Osteopsathyrosis.**—These terms are used to include conditions in which there is an undue fragility of the bones without there being any discoverable cause. This may occur in several members of the same family, or there may be no history of heredity. The bones are easily fractured; as a rule they unite normally, but in some cases union is much delayed and is associated with deformity. The fractures may occur before birth, or at any period of extra-uterine life. Skiagrams show an extraordinary atrophy of the diaphyses of the long bones, while the epiphyses and the joints are normal.

**Hypertrophic Pulmonary Osteo-Arthropathy.**—This condition, which was described by Marie in 1890, is nearly always secondary to disease in the chest, such as chronic phthisis, empyema, bronchiectasis, or sarcoma of the lung. There is symmetrical enlargement and deformity of the hands and feet; the shafts of the bones are thickened, and the soft tissues of the terminal segments of the digits hypertrophied. The fingers come to resemble drum-sticks, and the thumbs the clapper of a bell. The nails are convex, and incurved at their free ends, suggesting a resemblance to the beak of a parrot. There is also enlargement of the lower ends of the bones of the forearm and leg, and effusions into the wrist and ankle-joints.

There is no tendency to pus formation or to disintegration of the joints. Skiagrams of the hands and feet show a deposit of new bone along the shafts of the phalanges and other bones.

## Tumours of Bone.

New growths which originate in the skeleton are spoken of as *primary tumours*, while those which invade the bones, either by metastasis from other parts of the body or by direct spread from adjacent tissues, are known as *secondary*. They may grow from the periosteum, the marrow, or, in the case of young bones, from the epiphysial cartilage.

Primary tumours are always of the connective-tissue type, and are usually solitary, although certain forms, such as chondroma, osteoma, myeloma, and sarcoma are sometimes multiple from the outset.

*Periosteal tumours* are in the first instance usually situated on one side of the bone, but they may come to surround it completely. They are bounded externally by the fibrous layer of the periosteum, which, however, is infiltrated and perforated by malignant tumours.

*Central or medullary tumours* usually lead to absorption of the osseous tissue in immediate relation to them, while new bone is laid down externally. The bone as a whole may thus be greatly increased in girth, and is apparently "expanded" by the growth in its interior. Whether or not a central tumour invades the investing soft parts depends on the rapidity of its growth, and on the activity of the periosteum in forming new bone.

It is frequently observed that tumours of bone follow upon injury. The causal connection between the injury and the development of the tumour is not established; it may be that the trauma merely hastens the growth of an already existing tumour, or that it excites growth in embryonic residues resulting from some irregularity in development.

**Primary Tumours—Osteoma.**—This variety of tumour is called an *exostosis* when it projects from the surface of a bone. When derived directly from the tissues of the periosteum, for example, in the skull, it is described as a *membranous exostosis*—and it is usually dense and compact like ivory, hence the term *ivory exostosis*. When derived from hyaline cartilage—for example, at the ends of the long bones—it is known as a *cartilaginous exostosis*. This is invested with a cap of cartilage from which it continues to grow until the skeleton attains

maturity. Because of its spongy structure it is also described as a *cancellous or spongy exostosis.*

An exostosis forms a rounded or mushroom-shaped tumour of limited size which may be either sessile or pedunculated, and its free surface is smooth or nodulated. A cartilaginous exostosis in the vicinity of a joint may be invested with a synovial sac or bursa—the so-called *exostosis bursata.* The bursa may be derived from the synovial membrane of the adjacent joint with which its cavity sometimes communicates, or it may be of adventitious origin; when it is the seat of bursitis and becomes distended with fluid it may prevent the recognition of the underlying exostosis.

*Clinically*, the osteoma is met with as a hard, indolent tumour attached to a bone. Unless it presses injuriously on adjacent structures it is usually discovered accidentally. The special symptoms to which it gives rise vary with its situation. In the vicinity of a joint it may interfere with movement; at the inner side of the knee it may knock against the other limb, or incapacitate the patient from riding. When growing from the dorsum of the terminal phalanx of the great toe—subungual exostosis—it displaces the nail and may project through its matrix at the top of the toe, while the soft parts over it may be ulcerated from pressure (Fig. 87). When it presses on the nerves of a limb it causes pains, cramps, and other nerve symptoms. In the orbit it displaces the eyeball; in the nasal fossæ and in the external auditory meatus it causes obstruction, which may be attended with ulceration and discharge. In the skull it may project from the outer table forming a smooth rounded swelling, or it may project from the inner table and press upon the brain.

The diagnosis of osteoma is to be made by the long duration and slow growth of the tumour, its hardness, and by the shadow which it presents when examined by the X-rays.

*Treatment.*—An osteoma which does not cause symptoms may be left alone. If causing symptoms, it is removed by dividing the neck or base of the tumour with a strong chisel, care being taken to remove the whole of the overlying cartilage. The dense varieties met with in the bones of the skull present greater difficulties; if it is necessary to remove them, the base or neck of the tumour is perforated in many directions with highly tempered drills rotated by some form of mechanical engine, and the division of the bone completed with the chisel.

The *multiple exostoses* met with in childhood and youth are

chondromata which have undergone ossification; they usually cease growing when the skeleton reaches maturity. They are met with chiefly in the vicinity of the most active epiphyses—that is, in the region of the knee, shoulder, and wrist; are often symmetrical, and vary greatly in size. They originate from the ossifying junctions of the long bones, and as the shaft increases in length may come to lie at some distance from the epiphysis. They may also grow from flat bones, such as the scapula and pelvis. Their anatomical characters are well brought out by the X-rays.

From the fact that the disease is usually inherited, and that, in addition to the multiple tumours, there are often an arrest of growth and curvature of several of the long bones, it is assumed that there is a widespread disturbance in the development of the skeleton dating from intra-uterine life. There is no indication for surgical interference, but if any particular tumour is a source of inconvenience it is easily removed by chiselling through its neck.

*Diffuse Osteoma, Leontiasis Ossea.*—This rare disease was described by Virchow, and named leontiasis ossea because of the peculiar disfigurement to which it gives rise. It usually commences as a diffuse overgrowth of the upper jaws in young adults. These bones are enlarged in all directions and project as prominent bosses on the face, and the nasal fossæ and the maxillary and frontal sinuses become filled up with bone, which encroaches also on the orbital cavities. In addition to the hideous deformity, the patient may suffer from blocking of the nose, loss of smell, and protrusion of the eyes, sometimes followed by loss of sight. The disease may spread to the malar and frontal bones, the vault of the skull, and to the lower jaw. The base of the skull is usually exempt. The disease is of slow progress and may become arrested; life may be prolonged for many years, or may be terminated by brain troubles or other intercurrent affections. In certain cases it is possible to remove some of the more aggressive of the bony masses. A less aggressive form of the disease is sometimes met with confined to the upper jaw on one side, and in a case of this variety, under our own observation, the disfigurement, which was the only subject of complaint, was eliminated by paring away the excess of bone by means of a chisel.

A remarkable form of unilateral hypertrophy and diffuse osteoma of the skull has been observed by Jonathan Hutchinson and Alexis Thomson following very accurately the distribution of the fifth nerve on one side.

**Chondroma.**—Cartilaginous tumours grow from the long bones and from the scapula, ilium, ribs, or jaws. They usually project from the periosteal surface of the bone, and may attain an enormous size; sometimes they grow in the interior of a bone, the so-called *enchondroma*.

The cartilage composing the tumour frequently undergoes myxomatous degeneration, resulting in the formation of a glairy, semi-fluid jelly, and if this change takes place throughout the tumour it forms a cyst. On the other hand, the cartilage may undergo calcification or ossification. The most important transition of all is that into sarcoma the so-called *malignant chondroma* or chondro-sarcoma, which is associated with more active growth, and parts of the tumour may be carried off in the blood-stream and give rise to secondary growths, especially in the lungs.



Fig. 236.—Multiple Chondromata of Bones of Hand.

(Anatomical Museum, University of Edinburgh.)

The innocent chondroma is met with as a slowly growing tumour, which is specially common in the bones of the hand, often in a multiple form (Fig. 236). The surface is smooth or lobulated, and in consistence the tumour may be dense and elastic like normal cartilage, or present areas of softening, or of bony hardness. The skin moves freely over it, except in relation to the bones of the fingers, where it may become adherent and ulcerate, simulating the appearance of a malignant tumour. Large tumours growing from the bones of the extremities may implicate the main vessels and nerves (Fig. 237), either simply surrounding them, or pressing on them so as to cause symptoms.

The prognosis varies with the rate of growth; if growing very slowly the probability is that it is innocent; rapid growth is an indication of malignancy.

*Treatment.*—It is necessary to remove the whole tumour. In chrondromata growing from the surface of the bone, especially if they are pedunculated, this is comparatively easy. When an

entire bone, such as the scapula or lower jaw, is involved, it is better to excise the bone, or at least the part of it which bears the tumour. In the case of central tumours the shell of bone is to be removed over an area sufficient to allow of the enucleation of the tumour, or the affected portion of bone is resected. Should there be evidence of malignancy, early amputation is called for.

The chondromata which undergo ossification concurrently with the skeleton, have been described with the osteomata.

**Fibroma** is met with chiefly as a periosteal growth in relation to the mouth and pharynx, the simple epulis of the alveolar margin and the naso-pharyngeal polypus being the most common examples. They will be described with the special regions in which they occur.

*Myxoma*, *lipoma*, and *angioma* of bone are all very rare.

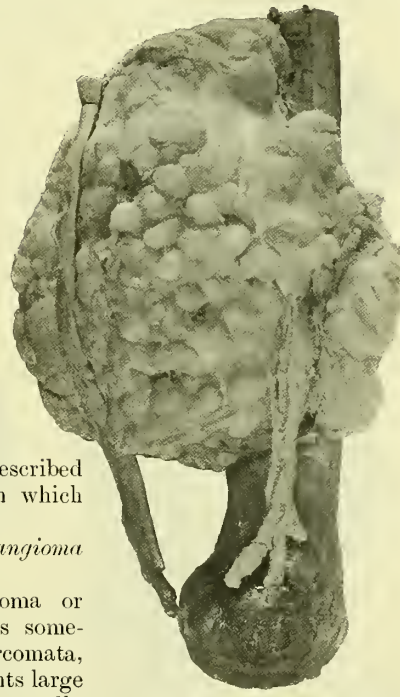


Fig. 237.—Chondroma of Femur. The femoral vessels pass through the substance of the tumour, and the sciatic nerve is adherent to its surface.

**Myeloma.**—The myeloma or myeloid tumour, which is sometimes classified with the sarcomata, contains as its chief elements large giant cells, like those normally present in the marrow. These tumours usually present a brownish-red or chocolate colour, and being very vascular are liable to hæmorrhages, to pigmentation, and to the formation of blood cysts. Sometimes the arterial vessels are so dilated as to impart to the tumour an aneurysmal pulsation and bruit. The enlargement or "expansion" of the bone may result in the cortex being represented by a thin shell of bone, which may crackle on pressure—egg-shell crackling. The tissue of the tumour may liquefy so as to form a single or a multilocular cyst, and it is in this way that the majority of cysts of bone originate.

The myeloma is most often met with in the bones in the region of the knee of adolescents (Fig. 238); it grows slowly and without much pain, and may even become quiescent. It may be mistaken for tuberculous disease, for a gumma, a Brodie's abscess, or, if it pulsates, for popliteal aneurysm.



Fig. 238.—Myeloma of Head of Tibia. The patient had formerly sustained a fracture of the fibula.

(Museum of Royal College of Surgeons, Edinburgh.)



Fig. 239.—The Femur of a boy æt. 12, showing the Bony Shell of a large Cyst-like Cavity which communicates with the interior of the bone. The original tumour was probably a sarcoma.

(The specimen, which is in the Anatomical Museum, University of Edinburgh, is figured in Syme's *Principles of Surgery*.)

Although these tumours sometimes give rise to secondary growths presenting a similar giant-celled structure, they are, as a rule, innocent, and should be treated as such, either by shelling out the new growth, or by resecting the portion of bone in which it is lodged.

**Malignant tumours of bone.—Sarcomata** and **endotheliomata** are the commonest tumours of bone, and present wide variations in structure and in clinical features. Structurally, two main groups may be differentiated: (1) the soft, rapidly growing cellular tumours, and (2) those containing fully formed fibrous tissue, cartilage, or bone.

(1) The *soft cellular tumours* are composed mainly of spindle or round cells; they grow chiefly from the marrow of the spongy ends of the long bones, the diploë of the skull, the pelvis, vertebræ, and jaws. As they grow they may cause little alteration in the contour of the bone, but they eat away its framework and replace it, so that the continuity of the bone is maintained only by tumour tissue and pathological fracture is a frequent result. The small round-celled sarcomata are among

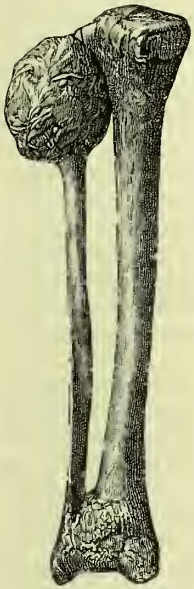


Fig. 240.— Periosteal Sarcoma of Head of Fibula, from child æt. 8.



Fig. 241.—Central Sarcoma of Lower End of Femur, invading the knee-joint.

(Museum of Royal College of Surgeons, Edinburgh.)

the most malignant tumours of bone, growing with great rapidity, and giving rise to secondary growths at an early stage.

(2) The second group includes the fibro-, osteo-, and chondro-sarcomata, and combinations of these; in all of them fully formed tissue predominates over the cellular elements. They grow chiefly from the deeper layer of the periosteum, and at first form a projection on the surface, but later tend to

surround the bone (Figs. 240 and 242), and to invade its interior, filling up the marrow spaces with a white, bone-like substance; in the flat bones of the skull, they may traverse the diploë and erupt on the inner table. The tumour tissue next the bone consists of a dense, white, homogeneous material from which there radiate into the softer parts of the tumour, spicules, needles, and plates of a bone-like material. The peripheral portion consists of friable sarcomatous tissue, which invades the overlying soft parts; the articular cartilage long resists destruction, and pathological fracture is exceptional. These ossifying sarcomata are met with most often in the femur and tibia, less frequently in the humerus, skull, pelvis, and jaws. In the long bones they may grow from the shaft, while the chondro-sarcomata more often originate at the extremities. Sometimes they are multiple, several tumours appearing simultaneously or one shortly after another. Secondary growths are met with chiefly in the lungs, metastasis taking place through the veins.



Fig. 242. — Periosteal Sarcoma of Tibia in a woman æt. 60.

*Clinical Features.* — Sarcomata are usually met with before the age of thirty, and are comparatively common in children. Males suffer oftener than females in the proportion of two to one.

The symptoms consist in the appearance of a tumour connected with a bone, and steadily increasing in size. In the case of a *periosteal sarcoma*, the swelling may be on one aspect of the bone or may surround it, and when the tumour occurs at the end of a long bone the limb frequently assumes a characteristic "leg of mutton" shape (Fig. 242). The surface may be uniform or bossed, the consistence varies at different parts, and the swelling gradually tapers off as it extends along the shaft. On firm pressure fine crepitation may be felt from crushing of the delicate framework of new bone.

A *central sarcoma* usually forms a more globular swelling, the limits of which are more clearly defined. The bone is more or less uniformly expanded and is at first densely hard, but in time there may be parchment-like or egg-shell crackling from

yielding of the thin, unresisting shell. The swelling may pulsate, and a bruit may be heard over it. The patient often complains of pain, which is aggravated by exertion and is worst at night. The pain is more severe before the tumour erupts on the periosteal surface. In advanced cases it may be impossible to differentiate between a periosteal and a central tumour.

The soft parts over the tumour may for a long time preserve their normal appearance; or they may become œdematous, and the subcutaneous venous network be evident through the skin. The local elevation of temperature over the tumour, which may amount to two degrees or more, is a point of diagnostic importance.

The adjacent joint usually remains intact, although its movements may be impaired by the mere bulk of the tumour. Sometimes there is effusion into the cavity of the joint, or portions of tumour tissue may invade it.

*X-ray Appearances.*—A central tumour shows expansion of the bone and partial or complete disappearance of the normal dark shadow, as a result of the replacement of bone by tumour tissue; in a periosteal tumour, the appearances vary according to the amount and arrangement of bony material formed in its substance; there is usually marked irregularity in the outline of the bone.

When the overlying soft parts are invaded, they become matted together and adherent to the skin, which is thinned out and finally sloughs. The tumour tissue then protrudes, fungates, and bleeds. Pathological fracture may be an early manifestation, especially if the tumour involves the shaft of the femur or humerus; it follows slight violence, and is unattended with much ecchymosis or swelling. The fracture rarely consolidates, although there is often an attempt at union by the formation of cartilaginous callus.

Suppuration may take place in the soft parts over the tumour, especially when an exploratory puncture has been made without proper precautions. Enlargement of the neighbouring lymphatic glands does not necessarily imply that they have become infected with sarcoma, for the enlargement may disappear after removal of the primary growth. Actual infection of the glands, however, may occur. As the tumour progresses, there is evening pyrexia, the patient emaciates, becomes worn out with pain, want of sleep, and superadded septic infection, and finally succumbs, with or without evidences of secondary growths. When secondary growths occur they are most frequently in the lung or pleura; but they may develop in any of

the organs or in other bones, or may be generalised throughout the body.

To obtain a reasonable prospect of cure by operation, the *diagnosis* must be made at an early stage of the disease. It may present considerable difficulty. The lesions likely to be confused with sarcoma are chronic inflammatory conditions of bone, such as Brodie's abscess, syphilitic gumma, tuberculous disease in the interior of the bone, innocent tumours and hydatid cysts. When sarcoma forms a swelling near a joint and is attended with synovial effusion and a local increase in temperature, the resemblance to tuberculous disease of the joint may be very close. Secondary cancer of bone may present the same clinical appearances as sarcoma, and may be mistaken for it unless its connection with a primary cancer elsewhere is recognised. Chief reliance is to be placed on information gained by examination with the X-rays, and by exploratory incision supplemented by microscopical examination of the tissue removed.

Skiagraphy is not only of assistance in differentiating new growths from other diseases of bone, but may also yield information as to the situation and nature of a tumour, which may have important bearings on treatment.

The *prognosis* varies with the period at which the tumour is recognised; with its malignancy as indicated by its rapidity of growth; and with its situation as bearing on the possibility of complete removal by operation. Growths on the skull, spine, or pelvis rarely lend themselves to surgical interference. In the limbs the prognosis is graver the nearer the disease is to the trunk, because of the greater uncertainty of the disease being completely removed, and also because of the greater mortality which attends high amputations.

The occurrence of pathological fracture is an unfavourable feature, as it implies that the disease has been in existence for a longer period than the history of the case would suggest. Periosteal tumours are less favourable than central ones, because they are more liable to give rise to metastases. Our own experience is that the majority of cases of sarcoma of bone succumb within one or two years to secondary growths in the lungs or elsewhere. According to König, the permanent cures amount only to 18 per cent.

*Treatment.*—Those tumours which lend themselves to operative interference should be removed at the earliest possible moment. The usual practice has hitherto been to perform amputation well above the growth where one of the bones of a limb is involved, and this is still to be recommended as a

routine procedure. It must be stated, however, that within recent years conservative operations of the nature of resections have been performed, and in some instances with success, even in the case of cellular sarcomata (Mikulicz).

Before proceeding to perform amputation for a supposed sarcoma the tumour should be cut into and examined to make certain of its nature.

In amputating, provided the tissues are divided well beyond the tumour, it is not always necessary to go as high as the joint above; skin-flaps with circular division of muscles is the method of choice. In tumours involving the upper end of the humerus, it is usually necessary to remove the shoulder girdle along with the arm. In cases where removal of the tumour can hold out no prospect of permanent recovery, discharge or hæmorrhage may be a sufficient indication for amputation; and in cases in which pain is a prominent feature, it may be worth while to trephine the shell of the bone, to relieve tension.

**Pulsating Hæmatoma or Aneurysm of Bone.**—A limited number of these are cavernous erectile tumours dating from a congenital angioma. The majority would appear to be the result of changes in a sarcoma, endothelioma, or myeloma. The tumour tissue largely or entirely disappears, while the vessels and vascular spaces undergo a remarkable development. The tumour may come to be represented by one large blood-containing space communicating with the arteries of the limb; the walls of the space consist of the remains of the original tumour, plus a shell of bone of varying thickness. The most common seats of the condition are the lower end of the femur, the upper end of the tibia, and the bones of the pelvis.

The *clinical features* are those of a pulsating tumour of slow development, and as in true aneurysms, pulsation and bruit disappear on compression of the main artery. The origin of the tumour from bone may be revealed by the presence of egg-shell crackling, and by examination with the X-rays.

If the condition is believed to be innocent, the treatment is the same as for aneurysm—preferably by ligation of the main artery; if malignant, amputation is called for.

**Secondary Tumours of Bone.**—These include all varieties of tumours which are capable of occurring by metastasis, and those which spread to the bone by direct continuity.

*Metastatic Tumours.—Secondary cancer* is a comparatively common disease in bone. Its characters depend on the nature of the primary growth from which it arises. The soft forms grow rapidly, and are characterised by eating away of the bone.

In slowly growing forms, there may be considerable formation of imperfectly organised bone, often deficient in lime salts; this condition may be widely diffused throughout the skeleton, and as it is associated with softening and bending of the bones it is known as *cancerous osteomalacia*. Secondary cancer of bone may not reveal itself clinically at all, or it may cause pains in the affected bones, or may suddenly attract notice by the occurrence of pathological fracture—as, for example, in the shaft of the femur or humerus. In the vertebræ, it is attended with a painful form of paraplegia which may involve the lower, or all four extremities. On the other hand, the disease may show itself clinically as a tumour of bone, which may be of considerable size, and may be mistaken for a primary sarcoma, unless the existence of the original cancer is discovered.

The cancers most liable to give rise to metastasis in bone are those of the breast, liver, uterus, prostate, and intestine.

*Secondary tumours derived from the thyroid gland* require special mention, because they are peculiar in that neither the primary growth in the thyroid nor the secondary growths in the bones are necessarily malignant. They are therefore amenable to operative treatment.

*Secondary sarcomata*, whether derived from primary growths in the bones or in the soft parts, are very much rarer than secondary cancers. They are of little clinical importance, as, with rare exceptions, they are quite beyond the range of operative treatment.

*Cancer of Bone resulting from Direct Extension from adjacent Soft Parts.*—In this group the bone is involved by the spread of the cancer in the same way as any other tissue. There are two clinical types. The first is met with in relation to *epitheliomata of mucous surfaces*—for example, the palate, gums, antrum, frontal sinus, auditory meatus, or middle ear. They will be described under these special regions. The second is met with in relation to *epithelioma occurring in a sinus*, the sequel of suppurative osteomyelitis or compound fracture. The patient has usually had a discharging sinus for a great number of years. The epithelioma originates at the skin orifice of the sinus, and spreads down to the bone and into its interior. Inside the bone the progress of the cancer is resisted by sclerosis and obliteration of the medullary canal, but although its progress is slow, the infiltration of the bone is often more extensive than would appear externally. It is recognised clinically by the characteristic epitheliomatous growth in the sinus and its vicinity, and by the offensive nature of the discharge. A similar epithelioma may arise in connection with a chronic ulcer of the

leg. The cancer may infect the femoral lymphatic glands. The operative treatment is influenced by the extent of the disease in the soft parts overlying the bone, and consists in wide removal of the diseased tissues, or in amputation.

*Cysts of Bone.*—With the exception of hydatid cysts, which have been already considered, cysts in the interior of bone are usually the result of the liquefaction of such tumours as chondroma, myeloma, or sarcoma.

# CHAPTER XXIX.

## DISEASES OF JOINTS.

Definition of terms—Ankylosis: *Varieties.* Diseases: Errors of development—Bacterial diseases: *Pyogenic; Tuberculous; Syphilitic; Acute rheumatism*—Diseases associated with certain constitutional conditions: *Gout; Chronic articular rheumatism; Arthritis deformans; Hæmophilia*—Diseases associated with affections of the nervous system: *Neuro-arthropathies; Charcot's disease*—Hysterical or mimetic affections of joints—Tumours and cysts—Loose bodies in joints.

**Definition of Terms.**—The term *synovitis* is applied to any inflammatory condition which is confined to the synovial membrane of a joint. Synovitis is usually associated with effusion into the cavity of the joint of fluid, which may be serous, sero-fibrinous, or purulent. As the term synovitis merely refers to the tissue involved in the inflammation, it should always be used with an adjective—such as gouty, gonorrhœal, or tuberculous—which indicates its distinctive pathological nature.

The terms *hydrops*, *hydrarthrosis*, and *chronic serous synovitis* are synonymous, and are employed when effusion into the joint is the most prominent clinical feature. Hydrops may occur apart from disease—for example, in the knee-joint, from repeated sprains—but is met with chiefly in the chronic and intermittent forms of synovitis which result from gonorrhœa, tuberculosis, syphilis, arthritis deformans, or arthropathies of nerve origin. It may occur also when there is a loose body in a joint.

*Arthritis* is the term applied when not only the synovial membrane but the articular surfaces, and it may be also the ends of the bones, are involved in the disease.

As in speaking of synovitis, so in using the term arthritis it is necessary to prefix a qualifying adjective which indicates its

nature. According to its etiology, arthritis may or may not be attended with effusion into the joint. When effusion is present it may be serous, as in arthritis deformans, or sero-fibrinous or purulent, as in certain forms of pyogenic and tuberculous arthritis. Wasting of the muscles in the vicinity of the joint is a constant accompaniment of arthritis. It affects especially the extensor muscles, is quantitative rather than degenerative, and the muscles do not show the reaction of degeneration. On account of the involvement of the articular surfaces, arthritis is apt to be followed by one or other form of ankylosis.

The term *empyema* is sometimes employed to indicate that the cavity of the joint is full of pus. It is observed chiefly in chronic suppurative disease of pyogenic or tuberculous origin, and is usually attended with the formation of abscesses outside the joint.

*Ulceration of cartilage* and *caries of the articular surfaces* are common accompaniments of the more serious and progressive forms of joint disease, especially those of bacterial origin. The destruction of the cartilage is usually preceded by the formation of granulation tissue derived from the synovial membrane or from the bone marrow; the granulation tissue eats into and replaces the cartilage, giving rise to defects or holes, which are spoken of as ulcers. Ulceration of cartilage and articular caries represent successive stages in the same destructive process, the disappearance of the cartilage being followed by exposure and disintegration of the subjacent bone. The occurrence of ulceration of cartilage and of articular caries is always attended with rigidity of the joint from involuntary muscular contraction, with marked wasting of muscles, and with starting pains. These *starting pains* are the result of sudden involuntary movements of the joint, and they occur most frequently just as the patient is dropping off to sleep. The muscles becoming relaxed the sensitive ulcerated surfaces are allowed to jar on one another, this causes sudden reflex contraction of the muscles, and the resulting movement being attended with severe pain wakens the patient with a start. Advanced articular caries is usually associated with some abnormal attitude and shortening of the limb, and sometimes with dislocation. It may be possible under anæsthesia to feel crumbling bony surfaces grate upon one another. When all the constituent elements of a joint are damaged or destroyed, it is said to be *disorganised*. Should recovery take place, repair is usually attended with union of the opposing articular surfaces either by fibrous tissue or by bone.

**Conditions of Impaired Mobility of Joints.**—*Rigidity* is the fixation of a joint by the involuntary contraction of muscles. It is sometimes called false ankylosis because it disappears completely under anæsthesia. It is of special value as a sign of disease in deep-seated joints, such as the hip. *Contracture* is the term applied when the fixation is due to permanent shortening of the soft parts surrounding the joint—for example, muscles, tendons, ligaments, fasciæ, and skin. As the structures on the flexor aspect are specially liable to undergo such shortening, contracture is nearly always associated with flexion. Contracture may result from disease of the joint, or from conditions outside it—for example, disease in one of the adjacent bones, or lesions of the motor nervous mechanism such as are met with in infantile paralysis.



Fig. 243.—Osseous Ankylosis of Femur and Tibia in position of flexion.

*Ankylosis* is the term applied when impaired mobility results from changes involving the articular surfaces of a joint. It is frequently combined with contracture and with thickening and induration of the capsular and other ligaments. Three anatomical varieties of ankylosis are recognised —(*a*) The *fibrous*, in which there are adhesions between the opposing surfaces, which may be in the form of loose isolated bands of fibrous tissue, or may bind the bones so closely together as to obliterate the cavity of the joint. The resulting stiffness, therefore, varies from a mere restriction of the normal range of movement, up to a close union of the bones which altogether prevents movement. Fibrous ankylosis may follow upon injury, especially dislocation or fracture implicating a joint, or it may result from any form of arthritis. (*b*) *Cartilaginous ankylosis* implies the fusion of two opposed cartilaginous surfaces. It is best seen between the patella and the trochlear surface of the femur in certain forms of tuberculous disease of the knee. The fusion of the cartilaginous surfaces is preceded by the spreading of a vascular connective tissue, derived from the synovial membrane, over the articular surfaces. Clinically, it is associated with absolute immobility. (*c*) *Bony*

*ankylosis* or synostosis is an osseous union between articulating surfaces (Figs. 243 and 244). It may follow upon fibrous or cartilaginous ankylosis, or may result from the fusion of two osseous surfaces which have lost their cartilage and become covered with granulations. In the majority of cases it is to be regarded as a reparative process, presenting certain analogies with the union of fractures. It may be a sequel of any disease of joints, and especially of such as are attended with suppuration.

In addition to those forms of osseous ankylosis, which are clearly reparative in nature, others occur, the etiology and pathology of which are as yet unknown. The name *arthritis ossificans* has been applied by Joseph Griffiths to one group of these exceptional cases. The alleged occurrence of ankylosis from mere disuse of a joint has not been corroborated.

The occurrence of ankylosis in a joint before the skeleton has attained maturity does not appear to impair the growth in length of the bones affected. Any arrest of growth which may occur probably depends more on changes in the epiphysial junctions resulting from the original disease than on fusion of the bones.

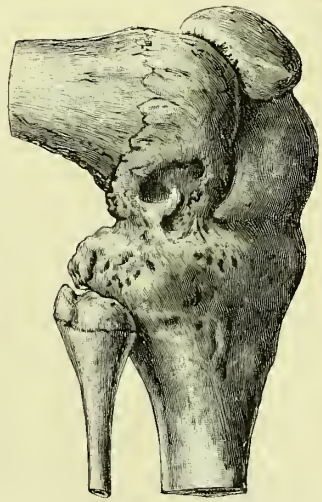


Fig. 244.—Osseous Ankylosis of Knee in the flexed position following upon Tuberculous Arthritis.

(Anatomical Museum, University of Edinburgh.)

In order to diagnose between muscular fixation and ankylosis, it may be necessary to anæsthetise the patient. The nature and extent of ankylosis may be learned by manipulating the limb or by skiagraphy. In fibrous ankylosis mobility may be elicited, although only to a slight degree and with pain; while in osseous ankylosis the joint is rigidly fixed, and attempts to move it are painless.

The *treatment* is influenced by the nature of the original disease, the variety of the ankylosis, and the attitude and functions of the joint concerned. In a case of fibrous ankylosis, if the aim is a movable joint, treatment is directed towards elongating or rupturing the fibrous union between the bones.

Elongation of the adhesions may be effected by manipulations, exercises, and the use of special forms of apparatus—such as extension, or the application of weights to the limb. Massage, douching, and electricity are also useful. This line of treatment, however, demands considerable patience and fortitude on the part of the patient, and unless he is encouraged by seeing evidence of the adhesions yielding, he is apt to abandon the treatment. It may be necessary to administer an anæsthetic in order to rupture strong fibrous adhesions, and these often give way with an audible crack. This procedure must be carried out with caution, in view of such risks as fracture of the bone—which is often rarefied—or separation of an epiphysis. There is also a risk of fat embolism, and of re-starting disease. In any case, the procedure is followed by considerable pain and effusion into the joint, which necessitate rest for some days before exercises and manipulations are resumed. The adhesions which result from injury of a joint are more amenable to treatment than those which result from disease.

In selected cases of fibrous ankylosis, with or without contracture, it may be advisable to attempt to secure a movable joint by open arthrotomy, dividing or removing adhesions and other contracted tissues. This procedure, which has been named *arthrolysis*, has been practised chiefly in the elbow, and has yielded results which are distinctly encouraging. In order to prevent the reunion of articular surfaces, a layer of subcutaneous fat or a layer of fascia may be interposed.

If the ankylosis is osseous and a movable joint is desired—for example, at the elbow—a considerable amount of bone, and it may be also of periosteum and capsular ligament, may require to be resected to allow of the formation of a new joint.

On the other hand, if osseous ankylosis has occurred with the limb in a good position it should be left alone.

When bony ankylosis has occurred with the joint in an undesirable attitude—for example, flexion at the hip or knee, or extension at the elbow—it can only be remedied by osteotomy or by a wedge-shaped resection of the bone, with or without such additional division of the contracted soft parts as will permit of the limb being placed in the attitude desired. Fixation by means of pegs may hasten the occurrence of osseous union, and afford an additional security of the correct attitude being maintained.

Bony ankylosis of the joints of a finger, whether the result of injury or disease, is difficult to remedy by any operative

procedure, for while it is quite possible to restore mobility, the new joint is apt to be flail-like and useless. In those who find that a stiff finger is always in the way, and who have little regard for appearances, it is usually best to remove it.

**Errors of Development.**—These include congenital dislocations and other deformities of intra-uterine origin, such as abnormal laxity of joints, absence, displacement, or defective growth of one or other of the essential constituents of a joint.

The more important of these are described along with deformities.

## DISEASES OF JOINTS.

**Bacterial Diseases.**—In the great majority of bacterial diseases the organisms are carried to the joint in the blood-stream. They may lodge in the first instance either in the synovial membrane or in one of the adjacent bones, whence the disease subsequently spreads to the structures of the joint. Bacterial diseases resulting from infection of a penetrating wound are comparatively rare.

### Pyogenic Diseases.

The commoner pyogenic diseases are the result of infection of one or other of the joint structures with *staphylococci* or *streptococci*, which may be demonstrated in the exudation into the joint and in the substance of the synovial membrane. The mode of infection is the same as in the pyogenic diseases of bone. The localisation of the infection in a particular joint is determined by injury, exposure to cold, antecedent disease of the joint, or other factors whose nature is not always apparent. A distinction may be made between those diseases in which the organisms involve articular structures from the outset, and those in which the initial lodgment is in one of the adjacent bones. The former are more often met with in adults, and are illustrated by the joint suppurations in pyæmia; the latter are more frequent in children, and are illustrated by the "acute arthritis of infants," in which the joint lesion owes its origin to an osteomyelitis in one of the adjacent bones.

The *clinical features and morbid appearances* vary with the gravity of the infection. The disease may assume the form of an *acute serous synovitis*, which may recover, may become chronic, or may relapse after apparent cure. This *relapsing* or *inter-*

*mittent synovitis* or hydrops has been shown to depend in certain cases on chronic staphylococcal disease of one of the adjacent bones, such as Brodie's abscess, the treatment of which is essential for permanent recovery. It closely resembles the hydrops of gonorrhœal or tuberculous origin.

In certain cases of pyogenic infection the disease remains latent for a time, and the clinical manifestations are so slight that they may escape notice until some striking development, such as dislocation, draws attention to them. This latency is observed chiefly in the hip when the joint has become infected in the course of some acute illness, such as scarlet or typhoid fever, or pyæmia.

In the graver infections, the suppurative element is more prominent, the effusion into the joint soon becoming purulent, and there is general illness, often ushered in with a rigor. The local signs and symptoms are those of an *acute arthritis*, in which all the joint structures participate, and which, if left to itself, may result in disorganisation.

The synovial membrane is converted into granulation tissue; the ligaments and inter-articular cartilages share a similar fate. The articular cartilages, which are at first dulled and macerated, undergo fibrillation and necrosis, and separate in visible fragments. The marrow of the subjacent bone thus exposed becomes the seat of inflammation, and throws out granulations which appear on the articular surface and lead to the disintegration of bone described as articular caries (p. 635).

The joint is held rigid by the involuntary contraction of muscles, and the least attempt at movement causes severe pain. The slightest jar—even the shaking of the bed—may cause agony. Sleep is impossible, or is disturbed by starting pains. Distension of the joint and fluctuation may be evident, or they may be obscured by œdema of the overlying soft parts. Sometimes the entire limb is swollen and œdematous. If left to itself the joint usually becomes flexed.

The pus in the joint may perforate the capsule and spread in the surrounding tissues. Sooner or later the abscess ruptures on the surface and discharges through one or more sinuses. The final disorganisation of the joint, with destruction of its ligaments, may be indicated by abnormal mobility, by grating of the articular surfaces, or by dislocation. In the acute arthritis of infants, the epiphysis concerned may be separated and displaced. The progress of the local disease is associated with aggravation of the general symptoms, and the patient is poisoned with toxins and exhausted by suffering.

In the course of *pyæmia*, joints may become distended with pus without any pronounced changes in the joint structures, without local signs except those indicating the presence of fluid, and without much complaint on the part of the patient.

When the joint is infected through an external wound, either accidental or operative, the morbid anatomy and clinical features are similar to those described when the infection has been carried to the joint by the blood-stream; but the lesion is usually more severe and destructive, and is more likely to result in osseous ankylosis.

*The terminations* vary with the gravity of the infection and with the stage at which it comes under surgical treatment. In the milder forms recovery is the rule, with more or less complete restoration of function. In the more severe forms, and especially when several joints are involved, death may result from septic absorption. If the patient recovers, the joint or the entire limb may be permanently damaged. There may be fibrous or bony ankylosis, in a good or in a bad position, or there may be deformity from displacement or dislocation. From changes in the peri-articular structures there may be contracture of the limb in an undesirable position, and in young subjects there may be interference with the growth of the limb. The persistence of sinuses is usually due to disease in one or other of the adjacent bones.

The *diagnosis*, while easy and straightforward in the graver suppurative forms, may be difficult in the milder varieties, for these may resemble very closely the serous effusions met with in gonorrhœa or tuberculosis.

*The treatment* is governed by the same principles as guide us in the treatment of other pyogenic infections. The limb is immobilised and elevated in such an attitude that should stiffness occur there will be the least possible interference with function. Extension by weight and pulley may relieve symptoms and counteract any tendency to flexion.

An alternative line of treatment is the production of venous congestion after the method of Bier; it is sometimes remarkably efficacious in relieving the pain, and in arresting the progress of the infection. An important question is that of the withdrawal of the fluid from the joint. If this is in sufficient quantity to cause tension, or if it tends to persist, or if from the temperature and other indications there is reason to suspect that it is purulent, it should be withdrawn without delay. An exploring syringe may suffice in the serous variety; but the suppurative forms demand incision and drainage. In addition, the joint may be gently

washed out with salt solution or peroxide of hydrogen. It is a common experience that many forms of acute suppuration in joints—for example, the acute arthritis of infants, and the suppurations in pyæmia—yield at once to incision and drainage if carried out sufficiently early and before any destructive changes have taken place.

In other cases simple drainage may not prove satisfactory, and indications of progressive mischief call for further interference. Continuous irrigation with several openings for drainage may be tried, or the joint may be laid freely open so that every pocket and recess is exposed. In certain joints this is only attainable by the resection of one or other of the bones.

Suppuration in the peri-articular soft parts or in one of the adjacent bones must be looked for and promptly dealt with by operation.

Amputation is only to be had recourse to if life is threatened by general infection.

When convalescence is established, attention is directed to the restoration of the functions of the limb, to the prevention of stiffness and deformity by movements and massage, and the use of hot-air and other baths.

At a later stage, and especially in neglected cases, operative and other measures may be required for deformity or stiffness.

**Other Forms of Pyogenic Infection.**—In *typhoid fever*, joint lesions may result from infection with the typhoid bacillus or with ordinary pyogenic organisms. They have been observed to run their course with or without suppuration. They are sometimes remarkably latent, especially in the hip-joint, and may result in dislocation on slight movement, or on lifting the patient. They are usually amenable to treatment, but sometimes ankylosis occurs.

Joint lesions are comparatively common in *scarlet fever*; they were formerly described as scarlatinal rheumatism. The most frequent clinical type is that of a serous synovitis, occurring within a week or ten days from the onset of the fever. It is most common in females over fifteen years, and its favourite seat is in the hand and wrist, the sheaths of the extensor tendons as well as the synovial membrane of the joints being involved. It does not tend to migrate to other joints, and rarely lasts longer than a few days. It is probably due to the specific virus of scarlatina.

An arthritis is sometimes met with which may be acute and suppurative, may affect several joints, and may exhibit a grave

septicæmic or pyæmic character. It occurs chiefly in children at a later stage of scarlet fever, and in cases in which the throat lesion is severe.

There is also described a "true rheumatic arthritis" occurring when convalescence from scarlet fever is well advanced; this form is favourably influenced by anti-rheumatic remedies, and is sometimes complicated with endocarditis and with chorea.

*Pneumococcal arthritis* is met with chiefly in one of the large joints in adult males, as a primary affection or as a complication of pneumonia. The changes in the joint affected and the clinical features are those common to all acute pyogenic infections, and the differential diagnosis can only be established by aspiration and bacteriological examination of the fluid in the joint. The treatment is by early incision and drainage. The prognosis depends on the presence or absence of general pneumococcal infection.

In *measles*, *diphtheria*, *smallpox*, *influenza*, and *dysentery*, joint lesions may occur, but are less frequent than in typhoid or scarlet fever.

The joint lesions which accompany *acute rheumatism* may be provisionally included with the other members of this group. For a description of them the reader is referred to works on medicine.

**Gonorrhœal Affections of Joints.**—These include all forms of joint lesion associated with gonorrhœal urethritis or vaginitis, or with gonorrhœal ophthalmia. They may develop at any stage of the urethritis, and are most frequently met with when the infection has reached the posterior portion of the urethra; they have been observed, however, after the discharge has ceased and when there are only threads in the urine. There is no connection between the severity of the gonorrhœa and the incidence of joint disease. In women it may originate from a vaginitis, which is only to be distinguished from an ordinary leucorrhœa by bacteriological examination of the discharge.

As a complication of ophthalmia the joint lesions are chiefly met with in infants, and occur more commonly towards the end of the second or during the third week.

The joint lesions may be the only evidence of metastatic infection, or they may be part of a general gonorrhœal infection which involves the endocardium, the pleura, and the tendon sheaths. The gonococcus is carried to the joint in the blood-stream and is first deposited in the synovial membrane. On opening the joint, the gonococcus can nearly always be found in pure culture in the synovial membrane, although it may be impossible to find it in the exudate within the joint.

The joints most frequently affected are the knee, elbow, ankle, wrist, and fingers.

Several clinical types may be differentiated. (1) There is a *dry polyarthritis* met with in the wrist and hand, resembling chronic rheumatism and formerly described as gonorrhœal rheumatism, which in some cases is trifling and evanescent, and in others is persistent and progressive, and results in partial or complete stiffening of the affected joints and permanent crippling of the hand.

(2) The commonest type is a *chronic synovitis or hydrops*, in which the joint—very often the knee on one or both sides—fills with a serous or sero-fibrinous exudate. There is no thickening of the capsule and there are no inflammatory changes in the cellular tissue or skin. There is no fever or disturbance of health. The movements are free except in so far as they are restricted by the amount of fluid in the joint. It usually subsides in two or three weeks under rest, but may relapse. When recovery takes place it is usually complete.

(3) An *acute synovitis* with peri-articular phlegmon is the most characteristic type of gonococcal affection of joints. In our experience it is most often met with in the elbow, but it occurs also in the knee and ankle. There is sudden onset of severe pain and swelling in and around the joint, with considerable fever and disturbance of health. The slightest movement causes severe pain, and the part is very sensitive to touch. The skin is hot and tense, and in the case of the elbow may be red and fiery as in erysipelas.

The deposit of fibrin on the synovial membrane and on the articular surfaces may lead to the formation of adhesions, sometimes in the form of isolated bands, sometimes causing a close fibrous union between the bones, which may rapidly terminate in osseous ankylosis.

(4) A *suppurative arthritis*, like that caused by ordinary pus microbes, is met with. It may be the result of gonococcal infection alone or of a mixed infection. Only one joint is usually infected, but the condition may be multiple. The articular cartilages are destroyed, the ends of the bones are covered with granulations, and extra-articular abscesses form. Complete osseous ankylosis usually results.

*The diagnosis* of gonorrhœal affections of joints is often missed, because the possibility of gonorrhœa is not suspected by the practitioner. The denial of the disease by the patient is not always to be relied upon, especially in the case of women, who may be ignorant of its presence. The chief points in the differential

diagnosis from acute rheumatism are, that the gonorrhœal affection is more often monarticular, has little tendency to wander from joint to joint, and its progress is not appreciably influenced by salicylates, although these drugs may relieve the pain; the fever is not so high, and there is greater tendency to rapid stiffening of the affected joint. The conclusive point is the recognition of a gonorrhœal discharge or of pus threads in the urine.

*The prognosis* should always be guarded, because the disease may prove persistent or may relapse, and the patient may be laid up for weeks or months, and may finally be crippled in one or in several joints.

*The treatment*—besides that of the urethral disease or of the ophthalmia—consists in rest until all pain and sensitiveness have disappeared. Salicylates or iodides may relieve suffering but are not curative. The pain is usually greatly relieved by passive congestion by Bier's method.

The joint is immobilised by means of a splint, or by cotton wool and an elastic bandage. Extension is employed in the case of the hip.

During the acute stages, great relief may be obtained from very hot baths, to which turpentine and black soap may be added. König recommends the use of tincture of iodine to the extent of blistering. In the persistent dry form hot-air baths may be employed. In hydrops, when the fluid persists, the joint should be tapped, the fluid withdrawn, and about one ounce of a 1 per cent. solution of protargol injected; the patient should be warned of the marked reaction which follows upon the injection. The purulent form is to be treated by incision and drainage.

After all symptoms have settled down, but not till then for fear of exciting relapse or metastasis, the joint may be massaged and exercised. Stiffness from adhesions is most intractable, and may, in spite of every attention, terminate in ankylosis. Forcible breaking down of adhesions under anæsthesia is not to be recommended. Ankylosis of the elbow is best treated by resection of the joint.

## Tuberculous Diseases.

Tuberculous diseases of joints result from bacillary infection of the synovial membrane or of the marrow of one of the adjacent bones, under conditions similar to those which have been described as occurring in tuberculous disease of bone.

From the anatomical point of view they may be divided into those in which the disease originates in the synovial membrane, and those in which it originates in one of the adjacent bones. The relative frequency of these two types varies with the age of the patient and with the joint affected. In children, the number of cases originating in the bones is approximately three times as great as of those originating in the synovial membrane, while in adults, the disease most frequently originates in the synovial membrane. As regards the joint affected, the maximum frequency of osseous lesions is found in the hip—in the proportion of five osseous to one synovial; in the knee and in the other large joints, the proportion is about equal (König). The predominance of bone lesions in childhood and youth is to be ascribed chiefly to the activity of the growth at the ends of the long bones.

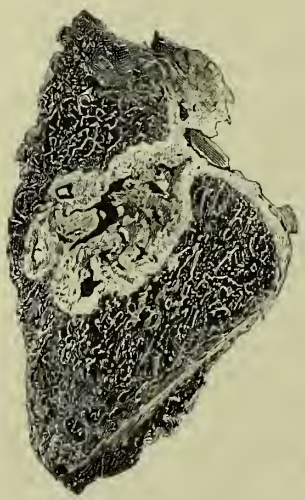


Fig. 245.—Section of Upper End of Fibula, showing caseating focus in marrow, erupting on articular surface and infecting joint.

**Morbid Anatomy.**—When there is tuberculous disease in the articular end of a long bone, it may give rise to reactive changes in the adjacent joint, characterised by effusion and by the prolongation of the synovial membrane over the articular surfaces. This may result in the formation of adhesions which obliterate the cavity of the joint or divide it into different compartments. These lesions are comparatively common, and are often erroneously regarded as resulting from tuberculous infection of the joint.

The actual infection of the joint with tubercle originating in the adjacent bone may take place at the periphery, the osseous focus reaching the surface of the bone at the site of the reflection of the synovial membrane, and the infection which begins at this point then spreads to the rest of the membrane. Or it may take place in the central area, by tuberculous pus escaping into the joint through a hole in the articular cartilage, or by the projection of tuberculous granulation tissue into the joint following upon gradual erosion of the cartilage (Fig. 245).

*Changes in the Synovial Membrane.*—In the majority of cases, the first evidence of disease in the joint is a *diffuse thickening of the synovial membrane*, due chiefly to the formation of granulation tissue, or of young connective tissue, in its substance. This new tissue may be described as being arranged in two layers—the outer layer composed of more fully formed connective or fibrous tissue, while the inner consists of embryonic tissue, usually permeated with miliary and other tubercles. On opening the joint these tubercles may be seen on the free surface of the synovial membrane, or the surface may be covered with a thin layer of fibrinous or caseous tissue, and a similar material may occupy the cavity of the joint. Where there is greater resistance on the part of the tissues, there is active formation of young connective tissue which circumscribes or encapsulates the tubercles, so that they remain embedded in the substance of the synovial membrane, and are only seen on cutting into it.

The new tissue formed in relation to the synovial membrane tends to be projected into the cavity of the joint, filling up its pouches and recesses, and spreading over the surface of the articular cartilages like ivy growing over a wall (Fig. 269). Wherever the synovial tissue covers the cartilage it becomes adherent to and fused with it, as covered cartilage always undergoes a retrograde metaplasia into ordinary connective tissue. The morbid process may be arrested at this stage, and may cure with fibrous adhesions between the opposing articular surfaces, or it may progress, in which case further changes occur, resulting in destruction of the articular cartilages and exposure of the subjacent bone.

In rare instances the synovial membrane may present nodular masses or lumps, resembling the tuberculous tumours met with in the brain. They project into the cavity of the joint, are often pedunculated, and may give rise to the same symptoms as a loose body. The fringes of the synovial membrane may also undergo a remarkable development, like that observed in arthritis deformans. Both these types are most frequently met with in the knee-joint.

*The Contents of Tuberculous Joints.*—In a large proportion of cases of synovial tuberculosis the joint cavity is entirely filled up by the diffuse thickening of the synovial membrane, and there is no fluid in the joint. In a small number there is an abundant serous exudate, and the condition is known clinically as tuberculous *hydrops*. There may be a considerable formation of fibrin within the joint, covering the free surface of the

membrane and floating in the fluid as shapeless flakes or masses. Under the influence of joint movements this fibrin may assume the shape of melon seed bodies (Fig. 254). More rarely the joint contains tuberculous pus, and the surface of the synovial membrane resembles the wall of a cold abscess.

*Ulceration of Cartilage.*—The synovial tissue covering the cartilage acquires the characters of a tuberculous infiltration and exhibits aggressive qualities. It then causes pitting and perforation of the cartilage, makes its way through it, and often spreads widely between it and the subjacent bone, so as to separate the cartilage, sometimes in portions of considerable size. These are the changes commonly spoken of as ulceration of cartilage. The cartilage is destroyed more rapidly and extensively when it overlies a focus in the bone, and the latter being then exposed in the joint, contributes to the progress of the disease.

*Caries of Articular Surfaces.*—Changes in the bone may precede or follow upon destruction of the articular cartilage. They consist in tuberculous infiltration of the marrow in the surface cancelli, and breaking up of the spongy framework of the bone into minute irregular fragments. This disintegration of the bone is known as caries.

When the destructive changes in the articular surfaces are very pronounced, and when at the same time there is an absence of caseation and suppuration, the condition is called *caries sicca.*

The mutual pressure of articular surfaces against one another favours the progress of ulceration of cartilage and of articular caries. These processes are usually more advanced in the areas most exposed to pressure—for example, in the case of the hip-joint, on the superior aspect of the head of the femur, and on the posterior and upper segment of the acetabulum.

The occurrence of *pathological dislocation* is due to softening and stretching of the ligaments which normally retain the bones in position, and to some factor causing displacement, which may be the accumulation of fluid or of granulations in the joint, the involuntary contraction of muscles, or some movement or twist of the limb. The occurrence of dislocation is also favoured by destructive changes in the bones.

*Peri-articular tubercle and abscess* may result from the spread of disease from the bone or joint into the surrounding tissues, either directly or by way of the lymphatics. A peri-articular abscess may spread in several directions, sometimes invading tendon sheaths or bursæ, and finally reaches the skin surface by tortuous sinuses.

Reactive changes in the vicinity of tuberculous joints are of common occurrence, and play a considerable part in the production of what is known clinically as *white swelling*. New connective tissue forms in the peri-articular fat and between muscles and tendons. It may be tough and fibrous, or soft, vascular, and œdematous, and the peri-articular fat becomes swollen and gelatinous, constituting a layer of considerable thickness from which tubercle may be entirely absent. This is what was formerly known as *gelatinous degeneration* of the synovial membrane. It is supposed that the fat disappears and is replaced by a mucoid effusion between the fibrous bundles of connective tissue, and that these changes result from interference with the circulation and nutrition of the tissues concerned. In the case of the wrist the newly formed connective tissue may fix the tendons in their sheaths, seriously interfering with the movements of the fingers. In relation to the bones there may also be reactive changes, resulting in the formation of spicules or scales of new bone on the periosteal surfaces and at the attachment of the capsular and other ligaments.

*Terminations and Sequelæ.*—A natural process of cure may occur at any stage of the disease, the tuberculous tissue being replaced by healthy connective and scar tissue. Recovery is apt to be attended with impairment of movement due to the occurrence of limited adhesions, ankylosis, or contraction of the peri-articular structures. Caseous foci in the interior of the bones may become encapsulated, and permanent cure thus be effected, or they may be the cause of a relapse of the disease at a later date. Interference with growth is comparatively common, and may involve only the epiphysial junctions in the immediate vicinity of the joint affected, or all the bones of the limb. This is sometimes well seen in adults who have suffered from disease of the hip in childhood—the entire limb, including the foot, being shorter and smaller than the corresponding parts of the opposite side.

Atrophic conditions are also met with, the bones undergoing fatty atrophy, so that in extreme cases they may be cut with a knife or may easily fracture. This is to be borne in mind in forcibly manipulating stiff joints. These atrophic conditions are recovered from if the limb is able to resume its functions.

*Relative Frequency in different Joints at different Ages.*—Tuberculosis of the hip and spine are essentially diseases of childhood and youth, and rarely commence after the skeleton has attained maturity. Disease of the knee is very common in children, but may be met with at any period of life. The elbow

and ankle exhibit little age preference, but are affected chiefly during childhood and youth. The wrist and shoulder are rarely affected in children.

**Clinical Features.**—These vary with the different anatomical forms of the disease, with the joint affected, and with the individual tendencies of the patient. The symptoms do not always correspond with the nature and severity of the local lesions, and it is not uncommon to find, when the joint is exposed by operation, that the disease is much more extensive than might have been inferred from the clinical features.

Sometimes the disease is ushered in by a febrile attack attended with pains in several joints—described by John Duncan as the "Tuberculous arthritic fever." This is liable to be mistaken for rheumatic fever, from which, however, it differs in that there is no real migration from joint to joint; there is an absence of sweating and of visceral complications; and no benefit follows the administration of salicylates.

In exceptional cases, tuberculous joint disease follows an acute course resembling that of the pyogenic arthritis of infants. This has been observed in young children, especially in the knee, the lesion being in the synovial membrane, and attended with an accumulation of pus in the joint. If promptly treated by incision and drainage recovery is rapid, and free movement of the joint may be preserved.

The onset and early stages of tuberculous disease, however, are more often insidious, and are attended with so few symptoms that the disease may have obtained a considerable hold before it attracts definite notice. It is not uncommon for patients or their friends to attribute the disease to injury, as it often first attracts attention after some slight trauma or excessive use of the limb. The symptoms may subside under rest, only to relapse again with use of the limb, and this may occur repeatedly.

The initial local symptoms may be those associated with the presence of a focus in the neighbouring bone, perhaps causing neuralgic pains in the joint, or weakness, tiredness, stiffness, and inability to use the limb, these symptoms improving with rest and being aggravated by exertion.

It is rarely possible by external examination to recognise deep-seated osseous foci in the vicinity of joints; but if they are near the surface in a superficial bone—such as the head of the tibia—there may be local thickening of the periosteum, œdema, pain, and tenderness on pressure and on percussion. Large foci may be revealed by the X-rays.

In the examination of the patient, attention must be specially

directed to the wasting of muscles, the impairment or loss of the normal movements of the joint, and the development of abnormal attitudes of the limb.

*Wasting of muscles* is a constant accompaniment of tuberculous joint disease. It is to be attributed partly to want of use, but chiefly to reflex interference with the trophic innervation of the muscles. It is specially well seen in the extensor and adductor muscles of the thigh in disease of the knee, and in the deltoid in disease of the shoulder. The affected muscles become soft and flaccid, they exhibit tremors on attempted movement, and their excitability to the faradic current is diminished. The muscular tissue may be largely replaced by fat.

*Impairment or loss of the normal movements* varies in degree according to the nature and seat of the disease. In the early stages of synovial tuberculosis the movements may be merely restricted in range. When any joint of the lower extremity is affected there is usually a limp in walking. When the articular surfaces are involved all movements, whether active or passive, are usually abolished, and the condition presented is one of fixation or rigidity. This results from involuntary contraction of the muscles; it disappears under an anæsthetic, but returns on waking. The recognition of rigidity is of great diagnostic value, especially in deeply seated joints such as the shoulder and hip, and in the spine.

*Abnormal attitudes of the limb* may precede other symptoms of joint disease, but are more frequently of later development. In very indolent and mild cases they may be absent altogether. They occur earlier, and are more pronounced in cases in which pain and other irritative symptoms of articular disease are well marked, and are best illustrated by the attitudes assumed in disease of the hip and knee. They are due to reflex or involuntary contraction of the muscles acting on the joint, with the object of placing it in the attitude of greatest ease, and they disappear under chloroform. With the lapse of time they not only become exaggerated, but may become permanent from ankylosis, or from contracture of the soft parts around the joint, and they do not disappear under chloroform.

*Startings at night*, which are frequently met with in the stage of muscular fixation, are to be regarded as indications that the disease of the articular surfaces is progressive. They are most often met with in cases which go on to suppuration.

*The formation of extra-articular abscess* is one of the commonest accompaniments of tuberculous joint disease. The abscess may appear early and form a prominent feature in the

clinical picture, or it may not develop till long after the original disease has subsided. It may develop so insidiously that it may not attract attention until it has attained considerable size, especially when associated with disease of the spine, pelvis, or hip. The abscess presents itself at definite situations in relation to the different joints, determined by the anatomical relationships of the capsule and synovial membrane to the surrounding tissues. When infected, the bursæ and tendon sheaths in the vicinity may influence the direction of spread of the abscess and the situation of resulting sinuses. When left to burst of itself, or when opened and allowed to become infected with pyogenic bacteria, there is not only the risk of aggravation of the disease and persistent suppuration, but there is a greater liability to general tuberculosis.

When sinuses form, they are often so tortuous that it is difficult to pass a probe down to the focus from which the abscess took its origin.

Infection of the lymphatic glands of the limb is exceptional as a result of joint disease, but may follow upon tuberculous infection of the skin around the orifice of a sinus.

The occurrence of *pyrexia* in tuberculous joint disease usually indicates suppuration, or the dissemination of the tubercle—for example, to the lungs or membranes of the brain. A slight rise of temperature in the evening may be induced in quiescent joint lesions by injury or by movement of the joint under chloroform, or by such extra exertion as a railway journey. The development and spread of an abscess may also be attended with an evening rise of temperature; but when the abscess is quiescent the temperature usually remains normal. A carefully taken temperature chart, therefore, may afford useful information as to the formation or spread of an abscess. When sinuses have formed and become septic, there may be a diurnal variation in the temperature of the type known as hectic fever (Fig. 6).

*Relative Frequency of Tuberculous Disease in different Joints.*—Hospital statistics lead us to place the various joints in the following order of frequency:—Spine, knee, hip, ankle and tarsus, elbow, wrist, shoulder. It is probable that the frequency in the joints of the upper extremity is understated because the subjects thereof are often treated as out-patients.

### Clinical Types of Tuberculous Joint Disease.

**Tuberculous hydrops** is nearly always the result of a purely synovial lesion, and its outstanding feature is the accumula-

tion of fluid within the joint. It is analogous to the ascitic form of peritoneal tuberculosis and to the effusion in tuberculous disease of the pleura. It is the chief representative of the "chronic simple synovitis" of the older authors. Inasmuch as it frequently terminates in recovery with a useful joint, it may be regarded as the least serious form of tuberculous joint disease. As it is most often met with in the knee, it will be described with the affections of that joint.

**Cold Abscess or Empyema of Joints.**—The special feature of this type consists in the accumulation of tuberculous pus within the joint. It is analogous to the purulent type of peritoneal tuberculosis and tuberculous empyema of the pleura. It is most often met with in the knee, and is usually the result of tuberculosis starting in the synovial membrane. It is met with in those who are much reduced in health, and who are the subjects of tuberculous lesions elsewhere. Its clinical features resemble those of hydrops so closely that the differential diagnosis is rarely made until the fluid is withdrawn by means of an exploring syringe. The prognosis is less favourable than in hydrops.

**Diffuse Thickening of the Synovial Membrane.—White Swelling of Joints.**—*Tumor albus* was the name originally applied by Wiseman in 1676 to that form of tuberculous disease which is characterised by the gradual development of an elastic swelling in the region of a joint. It has already been pointed out that this swelling is to a considerable extent the result of inflammatory and mucoid changes in the fat and connective tissue surrounding the capsule of the joint, as well as of tuberculous thickening of the synovial membrane. It may originate from tuberculosis starting in the synovial membrane as well as from disease in the bone. The changes within the joint and the course of the disease vary within wide limits. The appearances of white swelling bulk so largely in the clinical features of a large number of cases of tuberculous joint disease that it is probably the best-known clinical type. It is best illustrated in joints which are superficial—such as the knee, ankle, elbow, and wrist. The swelling, which is the first and most prominent clinical feature, develops gradually and painlessly, obliterating the bony prominences by filling up the natural hollows (Fig. 271). It appears greater to the eye than is borne out by measurement, being thrown into relief by the wasting of the muscles above and below the joint. In the early stage the swelling is elastic, doughy, and non-sensitive, and corresponds very accurately to the superficial area of the synovial membrane involved. At this stage there is comparatively little complaint on the part of the patient,

for the articular surfaces and ligaments are still intact. There may be a feeling of weight in the limb, and in the case of the knee and ankle the patient may tire on walking and drag the leg with more or less of a limp. The movements of the joint are painless, although usually somewhat limited in range. The disability is increased by use and exertion, but, for a time at least, it improves under rest.

As the disease progresses the signs and symptoms slowly become more marked. The skin over the joint becomes tense and hot, the swelling, which was at first firm and elastic, may show areas of softening, and later of fluctuation; and a cold abscess may form and produce one or more sinuses by bursting through the skin. The wasting of muscles increases, the joint becomes more rigid as the articular cartilages become affected, and the attitude of flexion is very commonly assumed, more especially in the case of the knee. Starting pains at night indicate destructive changes in the articular surfaces. The final condition tends to be one of disorganisation of the joint, with deformity and multiple sinuses.

**Tuberculous Arthritis.**—It is convenient to group under this heading those cases of tuberculous joint disease in which the early and outstanding clinical features are the result of implication of the articular surfaces. Although, as already indicated, these symptoms commonly develop in the later stages of white swelling, it is a matter of everyday experience that symptoms of implication of the articular surfaces may be the first evidence of tuberculous joint infection, and may exist without white swelling or any other clinical sign of disease in the synovial membrane. These remarks apply specially to such deeply seated joints as the hip, shoulder, and spine. The recognition of this form of tuberculous joint disease depends rather upon inferences founded upon certain symptoms and signs than upon direct examination of the joint itself. The patient complains of pain in the joint affected, or refers it to some other part which shares the same nerve-supply; for example, in hip disease the pain is often referred to the knee through the obturator nerve. The pain is aggravated by movement, and in the case of the joints of the lower extremity the patient limps in walking. The movements of the joint are restricted or abolished. Wasting of muscles is more marked than in the early stage of white swelling. Very commonly the limb assumes an abnormal attitude as a result of the contraction of particular groups of muscles.

In the more advanced stages, other signs may make their

appearance, such as starting pains, the formation of abscess and of sinuses, displacement or even dislocation of the bones. Under an anæsthetic the joint may be found to be completely disorganised, with destruction of ligaments, abnormal mobility, and grating of the articular surfaces.

*Caries sicca* is the name given by Volkmann to a very chronic form of tuberculous arthritis, which is met with chiefly in the shoulder and hip, between the ages of fifteen and thirty-five. There is an entire absence of swelling, a characteristic wasting of all the structures in the vicinity of the joint, and the bony prominences—such as the acromion and coracoid in the case of the shoulder, and the trochanter at the hip—stand out prominently. Passive movements are restricted and are attended with severe pain. The general health usually remains unimpaired in spite of the long duration of the disease. Suppuration is exceptional, and when it occurs is usually associated with the presence of a sequestrum.

*Influence of tuberculous Joint Disease on the General Health.*—Experience shows that the early stages of tuberculous joint disease may be compatible with the appearance of good health. As a rule, however, the general health suffers, the appetite is impaired, the patient is easily tired and complains of failure of strength, and there may be considerable loss of flesh.

Tuberculous disease of the lung is a frequent concomitant in adults, and may be present before the joint disease, or may appear later. In children, acute miliary tuberculosis may occur, and the clinical features are frequently those of tuberculous meningitis; it sometimes follows on comparatively trivial operations, and is usually rapidly fatal.

*Diagnosis.*—In typical cases the diagnosis is usually easy. A history of tuberculosis in the family, or of other tuberculous lesions in the patient, an insidious onset, and the fact that there is a considerable interval between the receipt of an alleged injury and the appearance of symptoms, all suggest the tuberculous origin of a given case of joint disease. The X-rays are of value chiefly in the recognition of osseous lesions. The use of Koch's tuberculin for diagnostic purposes is to be recommended in obscure cases. A minimum dose, which rarely exceeds 6 mg., is injected into the deltoid; this is followed by a general reaction—pyrexia with nausea,—and by a temporary intensification of the local signs—pain, tenderness, and muscular fixation.

*The prognosis* depends upon so many factors that it is impossible to make any general statement regarding it.

Recovery is seldom impossible, but the existence of tuberculous lesions elsewhere or of septic sinuses are unfavourable factors. While tuberculous lesions in children tend to become circumscribed, the tendency in adults is in the opposite direction. The milder forms of synovial tuberculosis may be entirely recovered from, but the more severe bone lesions tend to cause aggravated forms of joint disease which have little tendency to natural cure. The presence of bone lesions may be inferred from the mere persistence of the disease in spite of proper treatment. The locality of the disease is an important factor, the prognosis being much more unfavourable in the hip and spine than in other joints.

The length of time required for complete recovery necessarily varies, but may be stated generally as being from one to three years. The patient or his friends should be informed of this, and of the risk of relapse at some future period.

**Treatment.**—In addition to the general treatment of tuberculosis, which must always be enforced, local measures are to be employed. These may be described under two heads—the conservative and the operative.

*Conservative treatment* is almost always to be employed in the first instance, and particularly when the skin is still intact, as by it a larger proportion of cures is obtained with a smaller mortality and with better functional results than by operation.

*Treatment by rest* implies the immobilisation of the diseased limb until pain and tenderness have disappeared. The attitude in which the limb is immobilised should be that in which, in the event of subsequent stiffness, it will be most serviceable to the patient. Immobilisation may be secured by bandages, splints, extension, or other apparatus. *Extension* with weight and pulley is of great value in securing rest, especially in disease of the hip or knee; it eliminates muscular spasm, relieves pain and startings at night, and prevents abnormal attitudes of the limb. If, when the patient first comes under observation, the limb is in a deformed attitude which does not readily yield to extension, this should be corrected under an anæsthetic. The permanently deformed attitudes due to contraction of the soft parts or to ankylosis will be considered later.

*Injection of Iodoform.*—In hydrops and empyema of joints this is carried out on the same lines as have been described for tuberculous abscess. After the fluid contents of the joint are withdrawn, the iodoform is injected, and the injection may require to be repeated in a month or six weeks.

When there is no fluid in the joint—as, for example, in white

swelling—the conditions for distributing the iodoform are less favourable. In the knee, the joint may be divided into compartments by septa of connective tissue derived from the synovial membrane, and the iodoform must be introduced into all of them. The trocar must be thrust in all directions, successive parts of the joint being attacked at intervals of from ten to fourteen days. Injections into the substance of the synovial membrane are painful and less certain. Mikulicz and others have recommended the injection of iodoform into the adjacent bones when these are soft enough to allow of the entrance of the trocar. The iodoform remains in the tissues for long periods, and may be seen as a dark shadow in skiagrams.

After the injection of iodoform there is usually considerable reaction attended with fever (101° F.), headache, and malaise, and considerable pain and swelling of the joint. In some cases there is sickness, and there may be blood pigment in the urine. The severity of these phenomena diminishes with each subsequent injection.

The production of *venous congestion* as introduced by Bier is, if carefully supervised, an important adjuvant to the iodoform treatment. The congestion appears to act beneficially by stimulating the formation of connective tissue, and neutralising the toxins of the bacilli. Two or three turns of elastic webbing are applied over a layer of lint a short distance above the affected joint, sufficiently tightly to constrict the veins and produce a bluish-red tinge of the skin. To prevent œdema, the limb should be bandaged below the joint. The site of application of the elastic bandage should be frequently changed, to avoid injuring the skin and to diminish the tendency to wasting of the muscles. The congestion is maintained for from fourteen to eighteen hours each day, and in the interval the œdema around the joint may be dispelled by a bandage. The congestion should be persevered with until a month or two after the symptoms of the joint disease have disappeared. The congestion should be suspended for two or three days after the injection of iodoform.

The use of blisters and of the actual cautery has largely gone out of fashion, but these measures may be employed with benefit for the relief of pain when this is a prominent feature.

The application of the X-rays twice or thrice a week has proved beneficial in synovial lesions. Treatment by means of Koch's tuberculin is still on its trial. Conservative treatment

is only abandoned if improvement does not show itself after a thorough trial, or if the disease relapses after apparent cure.

*Operative Treatment.*—Other things being equal, operation is more often indicated in adults than in children, because after the age of twenty there is less prospect of spontaneous recovery, there is more tendency for the disease to relapse and to invade the internal organs, and there is no fear of interfering with the growth of the bones. The state of the general health may necessitate operation as the most rapid method of removing the disease. The social status of the patient must also be taken into account; the bread-winner, under existing social conditions, may be unable to give up his work for a sufficient time to give conservative measures a fair trial, and the children of the poor cannot always obtain the necessary attention.

The *local conditions* which decide for or against operation are differently regarded by different surgeons, but it may be said in general terms that operative interference is indicated in cases where the disease continues to progress in spite of a fair trial of conservative measures; in cases unsuited for conservative treatment—that is to say, where there is dislocation, separation of epiphysis, or deformity incapable of being otherwise rectified; where there are septic sinuses, and operation affords a reasonable prospect of getting rid of both the tuberculosis and the sepsis; and where the disease is associated with severe bone lesions or with infection of the lymphatics. Operative interference is indicated also when the result will be better than that likely to be obtained by conservative measures, as is often the case in the knee and elbow.

The nature of the operative interference in many cases can only be decided after exploration of the joint. The aim is to remove all the disease with the least possible impairment of function and the minimum sacrifice of healthy tissue. The more open the method of operating the better, so that all parts of the joint may be available for inspection. Such methods as permit of dislocating the joint are specially to be recommended, since this procedure affords the freest possible access for inspection and for removal of the disease. Cold abscesses should, if possible, be cured before operating on the joint. Diseased synovial membrane is removed with the scissors or knife. If the cartilages are sound, and if a movable joint is aimed at, they may be left; but if ankylosis is desired they must be removed. Localised disease of the cartilage should be removed and the bone beneath investigated. If the articular surface is exten-

sively diseased, a thin slice should be removed, and if foci are then revealed, it is better to gouge them out than to remove further slices of bone, as this involves needless sacrifice of the cortex and periosteum.

The limb should be rendered bloodless before commencing the operation. The technique should be antiseptic rather than aseptic, so as to diminish the chances of tuberculous infection of the wounded surfaces. With the same object, as well as to overcome any minute tuberculous foci which may have escaped detection, a small quantity of sterilised iodoform may be rubbed into the raw surfaces and recesses of the joint. Further details belong to the surgery of the individual joints.

While closure of the entire wound without drainage may be successful, it is safer to employ some means for preventing the accumulation of blood-clot.

The operations of *arthrectomy* and *excision* are those usually performed for the removal of tuberculous disease in any joint. By arthrectomy is meant the removal only of such synovial membrane and articular cartilage as is diseased ; while excision implies the removal of a portion of one or of both of the bones entering into the formation of the joint, along with the entire synovial membrane and cartilage ; but it should be stated that the original distinction between these procedures has largely disappeared. The modern operation for tuberculous joint disease sometimes partakes of the characters of an arthrectomy, sometimes of an excision, but in many cases neither of these terms would accurately describe the procedure which best meets the requirements of the case. The after-treatment is of considerable importance in order to obtain the maximum usefulness of the limb. Massage, douching, electricity, and exercises should be persevered with. When the patient is able to resume using the limb, the wasting of muscles is likely to be recovered from, and, in young subjects, the growth in length of the bones continues.

Operative treatment of deformities resulting from tuberculous joint disease has almost entirely replaced reduction by force ; the contracted soft parts are divided, and the bone is resected.

*Amputation* for tuberculous joint disease has become one of the rare operations of surgery, and is only justified when less radical measures have failed and the condition of the limb is affecting the general health of the patient. Amputation is most frequently called for in persons past middle life, and particularly when septic complications have supervened.

### Syphilitic Diseases of Joints.

Syphilitic affections of joints are comparatively rare, but it is probable that their frequency has been underestimated, many cases being incorrectly diagnosed. As in tuberculosis, the disease may occur primarily in the synovial membrane, or may be secondary to disease in one of the adjacent bones.

In the *secondary* stage of *acquired syphilis* the disease usually assumes the form of a *serous synovitis*—sometimes called syphilitic rheumatism—the joint becoming swollen, hot, and painful, and there may be a certain amount of fever. A chronic effusion or *hydrops* is met with almost exclusively in the knee; it is frequently bilateral, and is very insidious in its onset and progress, the patient usually being able to go about. Both the synovitis and the hydrops closely resemble the corresponding lesions resulting from gonorrhœa, but they rapidly and completely disappear under anti-syphilitic treatment.

In the *tertiary stage* the joint-lesions are more persistent and destructive, and consist in the formation of gummata, either in the deeper layers of the synovial membrane, or in the adjacent bone or periosteum.

Peri-synovial and peri-bursal gummata are often met with in relation to the knee-joint of adults of middle age, especially females. They are usually multiple; they develop very slowly, and they are rarely sensitive or painful. The patient may not apply for advice until the gummata have broken down and given rise to tertiary ulcers (Fig. 37). The simultaneous presence of indolent swellings, ulcers, and depressed scars over the knee-joint is very characteristic of syphilis. Before the gummata have broken down the condition may closely resemble tuberculous disease of the synovial membrane, but in the syphilitic affection the swelling is nodular, uneven, and irregular, and if the skin becomes red and tender, there is not the decided liquefaction and fluctuation met with in tuberculosis.

*Syphilitic osteoarthritis* results from gummata in the periosteum or marrow of the adjacent bones. There is a gradual enlargement of one or other of the bones, the patient complains of pains, which are worst at night, and at this stage the diagnosis from sarcoma may be very difficult. The disease may extend to the synovial membrane and be attended with effusion into the joint, or it may erupt on the periosteal surface and invade the skin, forming one or more sinuses. The further progress is complicated by the occurrence of pyogenic infection leading to necrosis of bone. In the knee-joint, the patella, or one of the

condyles of the femur or tibia, may furnish a sequestrum, which, by involving the articular surface, imparts to the disease a persistent character. In such cases anti-syphilitic treatment must be supplemented by operative measures directed to the removal of the diseased tissues. In the knee excision is rarely called for; but in the elbow it may be performed in order to obtain a movable joint.

*In inherited syphilis*, the earliest joint affections met with are those associated with the epiphysitis of infants, in which there may be an effusion into the adjacent joint, especially in the knee or elbow; and in exceptional cases pyogenic infection may be superadded, and pus form in the joint.

In older children, a primary synovitis is met with of which the most striking features are: its insidious development, its chronic course, symmetrical distribution, freedom from pain, the free mobility of the joint, and its association with other syphilitic stigmata, especially in the eye, and its tendency to relapse. The knees are the joints most frequently affected, and the condition usually yields readily to anti-syphilitic treatment without the functions of the joint being impaired.

The tertiary or gummatous joint lesions in inherited syphilis are the same as in the acquired disease.

## Joint Diseases accompanying certain Constitutional Conditions.

**Gout.**—*Arthritis Urica.*—Gout is a constitutional disease, one of the manifestations of which is that certain joints are liable to attacks of inflammation associated with the deposit of a chalk-like material composed of sodium bi-urate. This deposit takes place chiefly in the articular cartilage, it may be in streaks or patches towards the central area of the joint, or over the entire extent of the cartilage, which appears as if it had been painted over with plaster of Paris. The urates are really deposited in the substance of the cartilage, and not on its free surface. The surface of the cartilage is at first intact, but is liable to degenerate and necrose, and form what is known as a gouty ulcer, and this may extend through the cartilage and invade the substance of the bone. In the synovial membrane the deposit of urates is usually attended with effusion into the joint, while in the ligaments and peri-articular structures it leads to the overgrowth of fibrous tissue and the formation of adhesions. The metatarso-phalangeal joint of the great toe, on one or on both

sides, is that most frequently affected. The other joints of the foot, and those of the fingers, wrist, ankle, and knee, may also be attacked. The disease is met with chiefly in men after middle life.

The *clinical features* are very characteristic. There is a sudden onset, usually during the early hours of the morning, of excruciating pain; the joint becomes tensely swollen, red, and glistening, with engorgement of the veins and some fever. In the course of a week or ten days there is a gradual return to the normal. Such attacks recur once a year or oftener, becoming less acute but lasting longer, and the local phenomena tend to persist, the joint remaining permanently swollen and stiff. Masses of chalk form in and around the joint, and those in the subcutaneous tissue may break through the skin, forming indolent ulcers with exposure of the chalky masses—tophi—and until these are extruded or removed the ulcers do not heal (Fig. 246). The hands or feet may become seriously crippled, especially when the tendon sheaths and bursæ also are affected.



Fig. 246.—Gouty Arthritis of Joints of Fingers with chalk stones; note the asymmetry of the deformity.

The local *treatment* consists in employing soothing applications while the symptoms are acute; later—hot-air baths, massage, and exercises are indicated. It is remarkable how completely even the most deformed joints may recover their functions. The dietetic and medicinal treatment of gout is to be found in works on medicine.

**Chronic Rheumatism.**—The claims of this disease to be called rheumatic rest upon the following facts:—That it often follows upon acute articular rheumatism; that it may show exacerbations or relapses which are attended with pyrexia and are relieved by salicylates; that it is met with in patients who present a family history of acute rheumatism or of inflammation of serous membranes; and that there may be a history of chorea, erythema nodosum, rheumatic nodules, or other evidences of rheumatism.

The primary changes in the affected joints involve almost exclusively the synovial membrane and the ligaments; as well as the surrounding tendon sheaths and bursæ. They consist in

cellular infiltration and exudation, resulting in the formation of new connective tissue which encroaches on the cavity of the joint and gives rise to adhesions between the articular surfaces. This newly formed connective tissue tends to contract, causing deformity and stiffness. The articular cartilages may be transformed into connective tissue, with consequent fibrous ankylosis and complete obliteration of the cavity of the joint. The bones are affected only in so far as they undergo fatty atrophy, or alteration in their configuration as a result of partial dislocation. Osseous ankylosis may be observed, especially in the small joints of the hand and foot.

*Clinically*, the disease is chronic and usually incurable. It is usually poly-articular and may be met with in childhood and youth as well as in adult life. In some cases, pain may be so prominent a feature that the patient resists the least attempt at movement. In others, the joints, although stiff, may be moved but exhibit pronounced crackings. When there is much new connective tissue formed in relation to the synovial membrane the joint is swollen, and as the muscles waste above and below the joint the swelling presents a characteristic spindle-shape outline. Subacute exacerbations occur from time to time, with fever and aggravation of the local symptoms. Finally there is ankylosis with deformity, the patient becoming a helpless cripple. On account of the tendency to visceral complications, the tenure of life is uncertain.

From the nature of the disease *treatment* is for the most part palliative. Salicylates are only of service during the exacerbations attended with pyrexia. The application of soda fomentations, turpentine cloths, or electric or hot-air baths may be useful. Improvement may result from the general and local therapeutics available at such places as Bath, Buxton, Harrogate, Wiesbaden, or Aix. In selected cases, a certain measure of success has followed operative interference, which consists in a modified arthrectomy. The deformities resulting from chronic rheumatism are but little amenable to surgical treatment, and forcible attempts to remedy stiffness or deformity are to be avoided.

**Arthritis Deformans or Osteo-Arthritis** (*Chronic Rheumatic Arthritis*, *Rheumatoid Arthritis*, *Rheumatic Gout*, *Malum Senile*, *Traumatic or Mechanical Arthritis*).—Under the term arthritis deformans or osteo-arthritis are provisionally included a number of joint affections which in their etiology and clinical features differ widely from one another. Their inclusion in a common group can only be justified by confessing that we are ignorant of their essential nature. In the above list of synonyms,

therefore, we must be specially cautious in the use of those names which seem to indicate the cause of the disease. While these affections occur more commonly in families with rheumatic or gouty tendencies, and while they may be preceded by attacks of rheumatism or gout, it is by no means certain that they are of a rheumatic or gouty nature.

The term malum senile—implying, as it does, an association with the changes resulting from advancing years—is singularly inappropriate as applied to a disease which may be met with in childhood. Arbuthnot Lane's suggestion that the lesions under consideration are the result of trauma, while ingenious and instructive, can scarcely be accepted as applicable to all cases. It is easier, however, to express negative opinions in regard to arthritis deformans than to formulate positive views that are of real value.

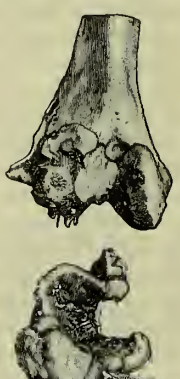


FIG. 247.—Arthritis Deformans of Elbow, showing destruction of articular surfaces and masses of new bone around the articular margins.

(Anatomical Museum, University of Edinburgh.)

*Morbid Anatomy.* — The articular cartilage at first presents a fibrillated appearance. Being of feeble vitality, it is gradually worn away as a result of the movements of the joint, until the subjacent bone is exposed. At the margins of the articular surfaces, where the synovial membrane and cartilage meet, there is an active proliferation of cartilage, resulting in nodular projections—*ecchondroses*—which have been compared in appearance to the droppings from a candle. These tend to be converted into bone, and the ossification thus started may extend into the capsular ligament, thereby adding to the articular margins a collar or "lip" of new bone, and also into other ligaments and into the insertions of tendons, giving rise to outgrowths of bone—*osteophytes* or *spurious exostoses* (Fig. 247).

The changes which take place within the articular area subsequent to the disappearance of the cartilage vary in different types of the disease. When rarefaction of bone is the predominant feature, the enlarged medullary spaces are opened into by the wearing away of the surface layer, and the bone then presents an erroded, worm-eaten appearance. In course of time there

may be considerable disappearance of bone and consequent alteration in shape and size—a change which is well illustrated

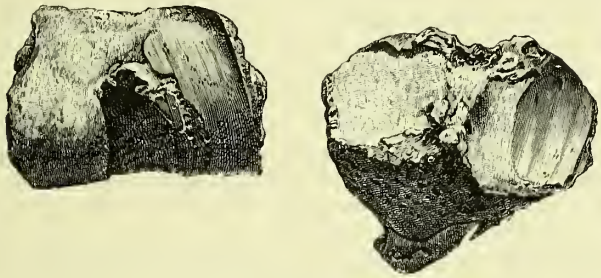


Fig. 248.—Arthritis Deformans of Knee, showing eburnation and grooving of articular surfaces.

(Anatomical Museum, University of Edinburgh.)

in the progressive enlargement of the acetabulum which takes place in certain cases of arthritis deformans of the hip. On the other hand, when the bone is condensed and sclerosed, it becomes smooth and polished as a result of the movements of the joint. When this change is very pronounced the appearance may be like that of ivory or porcelain and is described as *eburnation* of the articular surfaces. In hinge joints, such as the knee or elbow, the eburnated articular surfaces may present a series of parallel grooves corresponding to the lines of movement (Fig. 248).



Fig. 249.—Hypertrophied Fringes of Synovial Membrane in Arthritis Deformans of Knee.

(Museum of Royal College of Surgeons, Edinburgh.)

Although the joint may become locked by the amount of new bone formed around the articular margins, fibrous or bony ankylosis scarcely ever occurs.

In some cases the synovial membrane merely undergoes a degenerative alteration into cicatricial tissue with a marked tendency to contraction—*arthritis sicca.* In other cases it actively participates in the proliferative changes, becoming more vascular and thickened; and, as the result of hypertrophy of its fringes and enlargement and subdivision of its villi, becomes thickly set with elongated or club-shaped processes

which hang into the cavity of the joint (Fig. 249). The term *arborescent lipoma* is applied to the condition when fringes composed of fat are developed to an exaggerated degree. Individual fringes may undergo special enlargement and form pendulous growths, in the interior of which cartilage and bone may be formed; these may attain the size of a hazel-nut or even of a walnut. Whether they remain attached to the synovial membrane by their pedicles, or are free, they may give rise to the symptoms associated with the presence of a loose body in the joint (p. 676). When the synovial changes are prominent, there is usually considerable serous effusion into the joint, constituting one form of hydrops.

As regards the progress of the disease, it is usually observed that in patients who are still young its tendency is to advance



FIG. 250.—Arthritis Deformans of Hands, showing symmetry of lesions, ulnar deviation of fingers, and nodular thickening at inter-phalangeal joints.

with considerable rapidity, so that in the course of a few months it may cause serious crippling of several joints. In older patients its progress is much more gradual. The disease is quite compatible with long life.

*The dry form of arthritis deformans* (arthritis sicca), although specially common in the knee, is met with frequently in other joints, either as a monarticular or poly-articular disease; and it is also very common in the joints of the spine and of the fingers, as well as in the temporo-maxillary joint. In the joints of the fingers in older patients the disease is remarkably symmetrical, and tends to assume a nodular type (Heberden's nodes) (Fig. 250); whereas in younger subjects it assumes a more crippling, painful, and progressive fusiform type (Fig. 251). In the larger joints the subjective symptoms usually precede any palpable evidence of disease. The patient complains of stiffness, crackings, and aching, aggravated by

changes in the weather and by rest. The roughness due to fibrillation of the articular cartilages causes coarse friction on moving the joint. It may be months or even years before the lipping and other hypertrophic changes in the ends of the bones are recognisable, and before the joint assumes the deformed features which have given the disease its name.

The capsular ligament, except in cases of hydrops, becomes the seat of connective-tissue overgrowth, and tends to become contracted and rigid. Intra-articular ligaments, such as the ligamentum teres in the hip, are usually worn away and disappear. The surrounding muscles become atrophied, tendons become adherent to their sheaths and may become ossified, and nerves may be involved by the cicatricial changes in the tissues surrounding them.

The series of morbid changes, of which the above is a brief summary, may be described as presenting a remarkable combination of degeneration on the one hand, and overgrowth on the other, suggesting a profound disturbance of nutrition, the cause or causes of which are at present unknown.

*Clinical Features.*—The course of the disease as met with in persons past middle life is a very protracted one. It begins imperceptibly, and often many years pass before there is any pronounced disability. The earliest symptom is stiffness of a joint, especially in the morning after resting all night. The stiffness passes off temporarily with use of the limb, but as time goes on the range of movement becomes restricted and crackings occur. This stage of the disease may be prolonged indefinitely. If it progresses, stiffness becomes more pronounced, certain movements are lost altogether, others develop in abnormal directions, and the ends of the bones stand out prominently. In contrast with chronic rheumatism there is always some movement possible, and there is not the same tendency to contraction and to ankylosis.

*Hydrops* is frequent in the knee, and may be met with in the elbow, shoulder, and ankle; it may be associated with hydrops of the adjacent bursæ. The patient complains of a feeling of weight, of insecurity, and of tiredness in the joint. Pain is occasional and evanescent, and is usually the result of some extra exertion or exposure to cold and wet. As the joint becomes distended with fluid the ligaments are stretched, so that the limb becomes weak and unstable. The affection is extremely chronic, and may last for an indefinite number of years. It is to be diagnosed from the other forms of hydrops already considered—the purely traumatic, the pyogenic, gonorrhœal,

tuberculous, and syphilitic—and from that associated with Charcot's disease.

*Fringes and pendunculated, or loose, bodies* when added to hydrops give rise to characteristic clinical features, especially in the knee. The fringes, especially when they assume the luxuriance of what has been described as the arborescent lipoma, project into the cavity of the joint, and may fill up its recesses and distend its capsule. The joint is swollen and slightly flexed. Pain is not a prominent feature, the functions of the joint are but little impaired, and the patient may walk fairly well. On grasping the joint while it is being flexed and extended by the patient, the fringes may be felt moving under the fingers.



Fig. 251.—Arthritis Deformans affecting several Joints, in a boy æt. 10.

(Dr. Dickson's case.)

The patient may first apply for advice on account of the symptoms of loose body. The treatment applicable to this type is the removal of the hypertrophied fringes or of the loose body, by open arthrotomy, and is usually successful.

*Treatment.*—In the absence of definite knowledge of the etiology of the disease, treatment is directed chiefly towards the relief of symptoms. On no account should the affected joints be kept at rest. Passive movements, exercises of all kinds, massage, electric and hot-air baths, and douching are to be steadily persevered with. When pain is a prominent feature, it may be relieved either by douches of iodine and hot water (tincture of iodine 1 oz. to the quart), or by the application of lint saturated with a lotion made up of chloral hydrate, gr. v., glycerin ℥j., water ℥j., and covered with oil-silk. Operative interference by arthrectomy, arthrodesis, or excision is only indicated when the disease is of an aggravated type, when it is monarticular, and when the general condition of the patient is otherwise favourable. It has been

practised with success in the hip, knee, elbow, and temporo-maxillary joints.

A course of treatment at one of the reputed spas—Aix, Bath, Buxton, Gastein, Harrogate, Wiesbaden, Wildbad—is often of great service.

The patient should be nourished well, and there need be no restriction in the diet such as is required in gouty patients, so long as the digestion is not impaired. Benefit is also derived from the administration of cod-liver oil, and of tonics, such as strychnine, arsenic, and iron, and in some cases of iodide of potassium.

**Hæmophylic or Bleeder's Joint.**—This is a rare but characteristic affection, met with chiefly in the knee-joint of boys and young adult males who are the subjects of the hæmorrhagic diathesis. The first hæmorrhage into the joint originates suddenly after some trivial injury or without apparent cause. The temperature is often elevated (101°, 102° F.), especially if there are also hæmorrhages elsewhere in the body. The patient is usually anæmic. The joint is swollen, flexed, and as at first there is considerable pain the patient is obliged to lie up. In a few days everything settles down again, the blood in the joint is reabsorbed, and ecchymoses become visible.

After repeated hæmorrhages the joint becomes uniformly swollen. The synovial membrane is thickened, abnormally vascular, and coloured brown from the deposit of blood pigment. On the surface, and in parts also on the articular surfaces, there is a deposit of fibrin in process of organisation, adhesions form between opposing surfaces, and there are hæmorrhages of different dates in the surrounding muscles. As the swelling of the joint is associated with wasting of muscles, flexion, and stiffness, the resemblance to white swelling is very close—so much so, indeed, that a mistake in diagnosis has been made and the joint subjected to operation with disastrous results. The injection of tuberculin for diagnostic purposes should therefore be had recourse to in doubtful cases.

The treatment of a recent hæmorrhage consists in securing absolute rest and applying elastic compression. After an interval, measures should be adopted to promote the absorption of blood and to prevent stiffness and flexion; these include gentle massage, passive movements, and extension with the weight and pulley. Chloride of calcium may be administered internally with the object of preventing a recurrence of the hæmorrhage.

## Joint Diseases associated with Lesions of the Nervous System: Neuro-Arthropathies; Spinal Arthropathies; Charcot's Disease.

*In Lesions of Peripheral Nerves.*—In the hand, and more rarely in the foot, when one or other of the main nerve-trunks has been divided or compressed, the joints become swollen and painful, and may afterwards become stiff and deformed. Bony ankylosis has been observed in exceptional cases.



Fig. 252.—Bones of Knee-joint in advanced stage of Charcot's Disease. The inner part of the head of the tibia has entirely disappeared.

(Anatomical Museum, University of Edinburgh.)

In *Affections of the Spinal Cord.*—In myelitis, progressive muscular atrophy, infantile paralysis, insular sclerosis, and in traumatic lesions, joint affections are very rare, but they are not uncommon in locomotor ataxia and in syringomyelia.

The occurrence of joint lesions in *locomotor ataxia* (tabes dorsalis) was first described by Charcot in 1868 — hence the term "Charcot's disease" applied to them. Although they usually develop in the ataxic stage, one or more years after the initial spinal symptoms, they may appear before there is any other evidence of tabes. The onset is frequently determined by some injury to the joint. The joints of the lower extremity are most commonly affected, and the disease is bilateral in a considerable proportion of cases—both knees or both hips, for instance, being implicated (Fig. 268).

The first symptom of arthropathy is usually a swelling of the joint and its vicinity, often over a wide extent. There is no redness or heat and no pain

on movement. The peri-articular swelling, unlike ordinary œdema, scarcely pits even on firm pressure, and is much tenser.

In mild cases this condition of affairs may persist for months; in severe cases destructive changes ensue with remarkable rapidity. The joint becomes enormously swollen, loses its normal contour, and the ends of the bones become irregularly deformed (Fig. 252). Sometimes, and especially in the knee, the clinical features are those of an enormous hydrops with fibrinous and other loose bodies and hypertrophied fringes—and great œdema of the peri-articular tissues (Fig. 253). The joint is wobbly or flail-like from the stretching and destruction of the controlling ligaments, and is devoid of sensation. In other cases, wearing down and total disappearance of the ends of the bones is the prominent feature, attended with flail-like movements and with coarse grating in the joint. Dislocation is observed chiefly at the hip (Fig. 268), and is rather a gross displacement with exaggerated mobility than a typical dislocation, and it is usually possible to move the bones freely upon one another. An occasional and very striking feature is the extensive development of new bone in the capsular ligament and surrounding muscles, resulting in the formation of large masses and plates which may add materially to the already existing deformity. In certain cases the enormous swelling and its rapid development may suggest the growth of a malignant tumour. The most useful factor in diagnosis is the entire absence of pain, of tenderness, and of common sensibility. The freedom with which a tabetic patient will allow his



FIG. 253.—Charcot's Disease of Left Knee. The joint is distended with fluid.

disorganised joint to be handled requires to be seen to be appreciated.

The rapidity of the destructive changes in certain cases of tabes, and the entire absence of joint lesions in others, would favour the view that special parts of the spinal cord must be implicated in the former group in order to explain the arthropathies.

*In syringomyelia*, joint affections (gliomatous arthropathies) are more frequent than in tabes, and they usually involve the upper extremity in correspondence with the seat of the spinal lesion, which usually affects the lower cervical and upper dorsal segments of the cord (Fig. 257). Except that the joint disease is seldom symmetrical, it closely resembles the arthropathy of tabes. The completeness of the analgesia of the articular structures and of the overlying soft parts, is well illustrated by the fact that in one case the patient himself was in the habit of letting out the fluid from his elbow with the aid of a pair of scissors, and that the joint has been painlessly excised without an anæsthetic.

Suppuration, apart from superadded infection through a breach of the surface, does not occur in any of the forms of spinal arthropathy. Pathological fracture of one or other adjacent bones may occur.

The *prognosis* is uncertain, as the disease may become arrested or may go on to complete disorganisation of the joint.

*Treatment*, apart from that of the nerve lesion underlying the arthropathy, is usually directed towards retarding the progress of the disease, by supporting and protecting the joint by means of bandages, splints, and special apparatus. In the lower extremity, the use of crutches may assist in taking the strain off the affected limb. When there is much distension of the joint, considerable relief may follow withdrawal of the fluid. The best possible result being rigid ankylosis in a good position, when only one joint is affected and when the cord lesion is such as will permit of the patient moving about, it may be advisable to bring this about artificially by arthrodesis or resection. The wounds heal well, but the victims of tabes are unfavourable subjects for operative interference on account of their liability to intercurrent complications. When the limb is quite useless amputation may be the best course.

*In cerebral lesions* attended with hemiplegia, joint affections, characterised by evanescent pain, redness, and swelling, are occasionally met with in the paralysed limbs. The secondary

changes in joints which are the seat of paralytic contracture are considered with deformities.

*An intermittent neuropathic hydrops* has been observed—especially in the knee—in cases of epilepsy, hysteria, and general paralysis of the insane.

## Hysterical or Mimetic Joint Affections.

Under this heading Sir Benjamin Brodie, in 1822, described an affection of the joints, characterised by the prominence of subjective symptoms, and the absence of pathological changes. Although met with chiefly in young women with an impressionable nervous system, and especially among those in good social circumstances, it occurs occasionally in men. The onset may be referred to injury or exposure to cold, or may be associated with some disturbance of the emotions, or with disease of the generative organs; or the conditions may be an involuntary imitation of the symptoms of organic joint disease presented by another patient.

It is characteristic that the symptoms develop abruptly without sufficient cause, that they are exaggerated and wanting in harmony with one another, and that they do not correspond with the typical features of any of the known forms of organic disease. In some cases the only complaint is of severe neuralgic pains; more often these are associated with excessive tenderness, and with impairment of the functions of the joint. On examination the joint presents a normal appearance, but the skin over it is remarkably sensitive. A light touch is more likely to excite pain than deep and firm pressure. Stiffness is a variable feature—in some cases amounting to absolute rigidity, so that no ordinary force will elicit movement. It is characteristic of this, as of other neuroses, that the symptoms come and go without apparent cause. When the patient's attention is diverted, the pain and stiffness may disappear. There is never any actual swelling of the joint, although there may be an appearance of this from wasting of the muscles above and below If the joint is kept rigid for long periods, secondary contracture may occur—in the knee with flexion, in the hip with flexion and adduction—and attempts at movement may then cause cracking. The patient may remain in much the same condition for months or even years.

The *diagnosis* is often a matter of considerable difficulty, and the condition is liable to be mistaken for such organic lesions as

a tuberculous or pyogenic focus in the bone close to a joint, which may cause vague neuralgic pains for long periods before rupturing into the articulation. The use of the Röntgen rays, or examination of the joint under chloroform, may assist in difficult cases. The greatest difficulty is met with in the knee and hip, where the condition may closely simulate tuberculous disease.

The *local treatment* consists chiefly in improving the nutrition of the affected limb by means of massage, exercises, baths, and electricity. Splints are to be avoided. In refractory cases considerable benefit may follow the application of Corrigan's button or the actual cautery. The general condition of the patient must be treated on the same lines as in other neuroses. The Weir-Mitchell treatment may have to be employed in obstinate cases; the patient being secluded from her friends and placed in charge of a suitable nurse. Complete recovery is the rule, but when the muscles are weak and wasted from prolonged disuse, a considerable time may elapse before the limb returns to normal.

### Tumours and Cysts.

*Innocent tumours and sarcoma of the synovial membrane* are rarely recognised until explored by operation.

*Multiple cartilaginous bodies*, growing from the synovial membrane, are sometimes met with in the knee-joint; we have observed cases, all of them in women, in which the knee-joint was distended with several hundred such bodies, entirely composed of hyaline cartilage, some of them still attached to the membrane, the majority of them loose. On palpating the joint, the sensation imparted to the fingers is like that of grains of rice in a bag.

*Cysts of joints* constitute an ill-defined group which includes ganglia formed in relation to the capsular ligament. Cystic distension of bursæ which communicate with the joint is most often met with in the region of the knee in cases of long-standing hydrops. It was suggested by Morrant Baker that similar cystic swellings may result from the hernial protrusion of the synovial membrane between the stretched fibres of the capsular ligament, and the name "Baker's cysts" has been applied to these.

In the majority of cases cysts in relation to joints give rise to

little inconvenience and may be left alone. If interfered with at all they should be excised.

## Loose Bodies.

While there is probably no more controversial subject in surgical pathology than the origin and nature of loose bodies in joints, their clinical aspects and treatment are clear and straightforward. It is convenient to group them anatomically into two classes: those composed of fibrin, and those composed of organised connective tissue.

**Fibrinous Loose Bodies** (corpora oryzoidea).—These are homogeneous or concentrically laminated masses of fibrin, sometimes resembling rice grains, melon seeds, or adhesive wafers, sometimes quite irregular in shape (Fig. 254). Usually they are present in large numbers, but sometimes they are solitary and may then attain considerable dimensions. They are not peculiar to joints, for they are met with in tendon sheaths and bursæ, and their origin from synovial membrane may be accepted as proved. They occur in tuberculosis, arthritis deformans, and in Charcot's disease, and their presence is almost invariably associated with an effusion of fluid into the joint. While they may result from the coagulation of fibrin-forming elements in the exudate, their occurrence in tuberculous hydrops would appear to be the result of coagulation necrosis, or of fibrinous degeneration of the surface layer of the diseased synovial membrane. However formed, their shape is the result of mechanical influences, and especially of the movement of the joint.



Fig. 254.—Melon-seed Bodies from Tuberculous Knee-joint.

*Clinically*, loose bodies composed of fibrin constitute an unimportant addition to the features of the disease with which they are associated. They never give rise to the classical symptoms associated with impaction of a loose body between the articular ends of the bones. Their presence may be recognised, especially in the knee, by the crepitating sensation imparted to the fingers when the bodies are moved to and fro in the fluid.

The *treatment* is directed towards the disease underlying the hydrops. If it is desired to empty the joint, this is best done by means of an incision.

**Bodies composed of organised connective tissue.**—Bodies composed of fatty, fibrous, cartilaginous, or bony tissue are comparatively common in arthritis deformans; they are also met with in certain forms of synovial tuberculosis, and in Charcot's disease. They result almost exclusively from hypertrophic changes in the synovial fringes. They may consist of fat—for example, the arborescent lipoma; more commonly the connective-tissue cells of the fringes form fibrous tissue, cartilage, and bone in varying proportions and combinations (Fig. 255). Like other hypertrophies on a free surface, they tend to become polypoidal and pedunculated, and so acquire a limited range of movement. The pedicle or stalk may give way and the body become free. In this condition it may wander about the joint, or lie snugly in one of its recesses until disturbed by some exaggerated movement. It is alleged that a loose body free in a joint is capable of growth, deriving the necessary nutriment from the surrounding fluid.



Fig. 255.—Loose Bodies from Knee-joint, consisting of cartilage and bone.

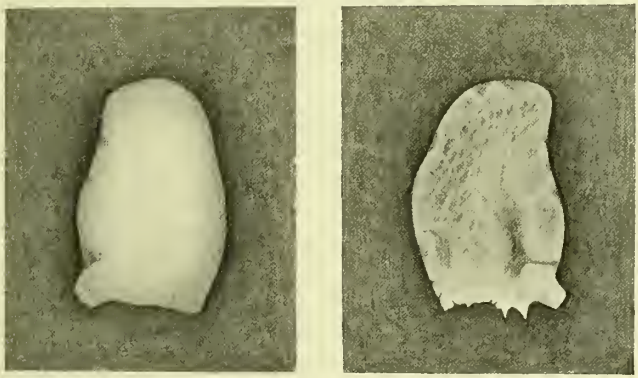
(Anatomical Museum, University of Edinburgh.)

The size and number of the bodies vary widely. Single specimens have been known to attain the size of the patella. The smaller varieties may number considerably over a hundred. In arthritis deformans a rarer type of loose body is met with, a portion of the lipping of one of the articular margins being detached by injury. In Charcot's disease, bodies composed of bone may be formed in relation to the capsular and other ligaments, and can be made to grate upon one another.

The *clinical features* in this group of organised loose bodies are mainly those of the disease which has given rise to them, and it is exceptional to meet with definite symptoms from impaction of the body between the articular surfaces. Treatment is to be directed towards the primary disease in the joint, as well as to the removal of the loose bodies.

*Loose Bodies in Joints which are otherwise Healthy.*—It is in joints otherwise healthy that loose bodies causing the classical symptoms and calling for operative treatment are most frequently met with. They occur chiefly in the knee and elbow of healthy males under the age of thirty. The complaint may be of vague pains, which are usually ascribed to rheumatism, of occasional cracking on moving the joint, or of impairment of function—usually

an inability completely to extend or flex the joint. In many cases a clear account is obtained of the characteristic symptoms which arise when the body is impacted between the articular surfaces. These are sudden onset of intense sickening pain, with loss of power in the limb and locking of the joint, followed by effusion and the other accompaniments of a severe sprain. On making some particular movement of the joint, the body may be disengaged, the locking disappear, and recovery take place as after an ordinary sprain. Attacks of this kind may recur at irregular intervals during a period of many years. On examining the joint it is usually found to contain fluid, and



*a* *b*

FIG. 256.—Loose Body from Knee-joint of man æt. 25. Natural Size.
*a* = Convex surface. *b* = Concave surface.

there may be points of special tenderness corresponding to the ligaments which have been sprained. The patient himself, or the surgeon, may be able to palpate the loose body and feel it roll beneath his fingers, especially if it is lodged in the supra-patellar pouch in the knee, or on one or other side of the olecranon in the elbow. In most instances the patient has carefully observed his own symptoms, and is aware not only of the existence of the loose body, but of its situation, when attached, or of its erratic appearance at different parts of the joint when free. When the body contains bone it may be visible in a skiagram. While in some cases the patient attributes his symptoms to an injury, exactly similar phenomena may occur apart altogether from traumatic influences. The treatment consists in opening the joint and removing the loose body.

The characters of these loose bodies are remarkably constant.

They are usually solitary, about the size of a bean or almond, concavo-convex in shape, the convex aspect being smooth like an articular surface, the concave aspect more often uneven and nodulated (Fig. 256). Such bodies may be lodged in a kind of compartment or excavation in one of the articular surfaces, usually one or other condyle of the femur, from which they may be readily shelled out by means of an elevator. They usually present on section a nucleus or core of spongy bone or of calcified cartilage.

As to the origin of these bodies, some maintain that they result from the detachment by injury of a portion of the articular surface, while others regard them as overgrowths derived from the synovial membrane. König regards them as portions of the articular surfaces which have been detached by a morbid process which he calls "osteochondritis dissecans."

*Displacement of the semilunar cartilages* in the knee is referred to with injuries of that joint (p. 548).

# CHAPTER XXX.

## DISEASES OF INDIVIDUAL JOINTS.

### The Shoulder-Joint.

Disease is rare in the shoulder in comparison with other joints, and as a rule is met with in adults. In young subjects, infective processes implicating the joint result chiefly from extension of disease from the upper epiphysial junction of the humerus, which is partly included within the limits of the synovial cavity. The synovial membrane, in addition to lining the capsular ligament, is prolonged down the bicipital groove around the long tendon of the biceps, and pus or other fluid may escape from the joint by means of this diverticulum and gravitate down the upper arm. There is frequently a communication between the joint and the sub-deltoid bursa. There is no characteristic attitude in disease of the shoulder-joint, but the girdle is usually elevated, the upper arm held close to the side and rotated slightly inwards, while the elbow is carried a little backwards. In the later stages, the head of the humerus may be drawn upwards and inwards towards the coracoid process. Fixation of the shoulder-joint is largely compensated for by the free movement of the scapula on the thorax, and when ankylosis occurs it is not so disabling as in other joints. In testing for rigidity the scapula should be fixed with one hand, while movements of the arm are carried out with the other. Swelling is rarely a prominent feature, except when there is a collection of fluid or an abscess in the bursa beneath the deltoid. The deltoid is usually atrophied, allowing the acromion, coracoid, and great tuberosity of the humerus to stand out prominently beneath the skin.

**Tuberculous Disease.**—This is met with chiefly in young adults, although it may occur at any age. It is more common in the right shoulder. The prominent features are pain, rigidity,

and wasting of the deltoid and scapular muscles. The pain may be severe, shooting down the arm and interfering with sleep, and it may be associated with tenderness on pressure over the upper end of the humerus. In cases with advanced carious destruction of the articular surfaces, there may be starting pains and the upper arm may be shortened. A cold abscess may form in the bursa underneath the deltoid, and the pus may burrow and appear at the anterior or posterior boundary of the axilla or in the axillary space. Pus formed in the joint may gravitate along the bicipital groove. The axillary glands may become infected.

The lesion underlying tuberculous disease of the shoulder, is either a large caseating focus in one of the bones — most often in the upper end of the humerus—or it is of the nature of caries sicca. The greater part of the head may disappear, and the upper end of the shaft be drawn against the socket. In exceptional cases, portions of the glenoid or humerus may be found separated as sequestra, or the disease may involve parts outside the joint, such as the acromion or coracoid process. Tuberculous hydrops with melon-seed bodies is rare. In young subjects destruction of the tissues at the ossifying junction may result in considerable shortening of the upper arm.

The *diagnosis* is to be made from (1) arthritis deformans, in which the movements are less restricted, and are attended with grating and crackling; (2) paralysis involving the deltoid and scapular muscles—by the absence of pain, and the free, or even flail-like, character of the movements; (3) disease in the sub-deltoid bursa—by the absence of rigidity and other evidence of implication of the articular surfaces; and (4) sarcoma of the upper end of the humerus by the use of the X-rays or of an exploratory incision.

While the *prognosis* is favourable on the whole, spontaneous recovery is usually attended with fibrous ankylosis and incapacity to raise the arm above the level of the shoulder. The disease is often very persistent, and may last for several years.

*Treatment.*—In the early stages rest is indicated. The limb should be immobilised in the position of slight abduction with the forearm and hand directed forwards. If the articular surfaces are affected and the disease is likely to result in osseous ankylosis, the arm should be abducted to a right angle. Severe pain may be relieved by blistering or by the application of the cautery. To inject iodoform the needle is introduced either

immediately outside the coracoid, or just below the junction of the acromion and spine of the scapula. Cold abscess is treated on the usual lines (p. 150). Operation is indicated in cases which do not yield to conservative measures. Excision of the joint is a very satisfactory operation, and although a close fibrous ankylosis usually occurs, the arm is a useful one.

**Pyogenic Diseases.**—The shoulder-joint may be infected by extension of suppurative periostitis and osteomyelitis from the upper end of the humerus, or from suppuration in the axilla, or through the blood-stream by ordinary pus organisms, pneumococci, typhoid bacilli, or gonococci. Extension should be applied to the upper arm abducted at a right angle. When it is necessary to drain the joint, the incision should be placed anteriorly in the line of the bicipital groove, and a counter-opening made on the posterior aspect by cutting on the point of a dressing forceps introduced through the anterior incision.

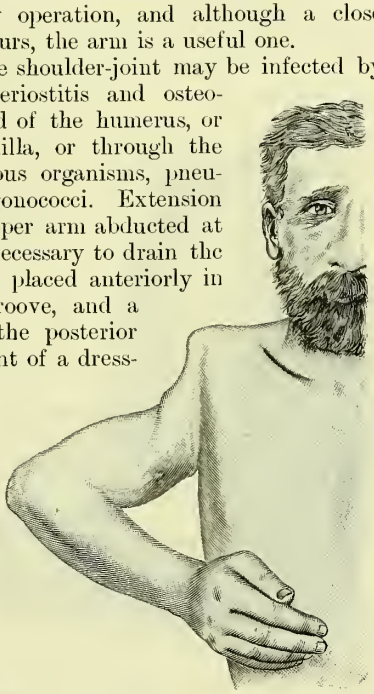


Fig. 257.—Arthropathy of Shoulder in Syringomyelia. The upper end of the humerus had disappeared and the movements were flail-like.

**Arthritis Deformans.**—The shoulder is seldom the only joint affected, except when the arthritis is a sequel to injury. The common type of lesion is a dry arthritis with fibrillation and subsequent eburnation of the articular surfaces. The long tendon of the biceps is usually destroyed, and the head of the bone may be drawn upwards, and, after wearing through the capsule, rubs on the under surface of the acromion. The prominent clinical features are pain, stiffness, and crackling on movement.

**Neuro-arthropathies** of the shoulder are met with chiefly in cases of syringomyelia. The clinical features may be a large and painless swelling with fluctuation, or marked and rapid wasting of the deltoid and scapular muscles with flail-like movements of the joint, associated with disappearance of the upper end of the humerus (Fig. 257).

## The Elbow-Joint.

In disease of the elbow, the usual attitude is that of flexion with pronation of the hand. Swelling of the joint, whether from effusion of fluid or from thickening of the synovial membrane, is perceived chiefly on the posterior aspect, above and on either side of the olecranon, because the synovial sac is here nearest the surface. The free communication between the elbow and the superior radio-ulnar joint should be borne in mind, in relation to disease of the elbow.

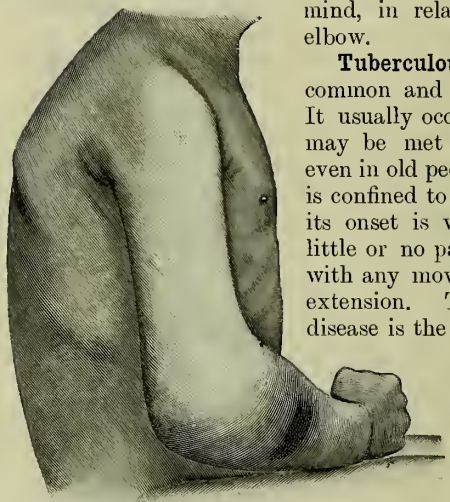


Fig. 258.—Diffuse Tuberculous Thickening of Synovial Membrane of Elbow (white swelling), in a boy æt. 12.

**Tuberculous disease** is the most common and important (Fig. 258). It usually occurs under twenty, but may be met with at any age, and even in old people. When the disease is confined to the synovial membrane its onset is very insidious, there is little or no pain, and no interference with any movement except complete extension. The only evidence of disease is the development of a white swelling on either side of and above the olecranon, obscuring the bony landmarks. The further progress is attended with wasting of the triceps, symptoms of involvement of the articular surfaces, and with abscess formation.

The occurrence of articular caries without swelling of the synovial membrane is exceptional, and is associated with a good deal of pain and considerable restriction of movement. Rigidity from muscular contraction occurs late, and is rarely complete. Tuberculous foci in the bones are met with chiefly in the upper end of the ulna and the lower end of the humerus; they may be recognised by swelling, and pain on making pressure over the bone. The grosser osseous lesions cause enlargement of the bone, and are readily demonstrated by skiagraphy. Abscess formation most commonly occurs beneath the triceps, and the abscess points at one or other edge of that muscle. A subcutaneous abscess may form over the upper end of the ulna or over the

radio-humeral joint. Tuberculous hydrops with melon-seed bodies is rare.

*Treatment.*— Conservative measures are indicated when there is a prospect of securing a movable joint. The limb is placed in a Thomas', Croft's, or poroplastic splint, flexed to rather less than a right angle and with the hand semi-pronated. To inject iodoform, the needle of the syringe is most easily introduced between the external condyle and the head of the radius. Cold abscess is treated on the usual lines (p. 150). A localised focus of disease in one or other of the bones may be eradicated without opening into the synovial cavity.

If the articular surfaces are so involved that recovery is likely to be attended with ankylosis, the disease should be removed by arthrectomy or excision. Cure of the disease with a useful and movable limb may then be reasonably anticipated within two or three months. When the patient's occupation is such that a strong, stiff joint is preferable to a weaker movable one, bony ankylosis at rather less than a right angle should be aimed at.

*Arthritis deformans* occurs as a hydrops with hypertrophy of the synovial fringes and loose bodies, or as a dry arthritis with eburnation and lipping of the articular margins (Fig. 247).

*Neuro-arthropathies* are met with chiefly in syringomyelia, and are attended with striking alterations in the shape of the bones and with abnormal mobility.

*Pyogenic diseases* result from staphylococcal osteomyelitis—chiefly of the humerus or ulna—and from gonorrhœa.

The remaining diseases at the elbow include syphilitic disease in young children, bleeder's joint, hysterical affections, and loose bodies, and do not call for special description.

## The Wrist-Joint.

The close proximity of the flexor sheaths to the carpal articulations enables infective processes to spread readily from one to the other. The arrangement of the synovial membrane also favours the extension of disease throughout the numerous articulations in the region of the wrist.

**Tuberculous disease** is met with chiefly in young adults, but may occur at any age. It usually originates in the synovial membrane, but foci are frequently present in the carpal bones, and less commonly in the lower ends of the radius and ulna, or in the bases of the metacarpals. The clinical features are almost invariably those of white swelling which is most marked on the back of the wrist, where it obscures the outlines of the bones and

of the extensor tendons. Wasting of the thenar and hypothenar eminences, and filling up of the hollows above and below the anterior annular ligament, render the appearance on the palmar aspect very characteristic.

The attitude is one of slight flexion with drooping of the hand and fingers. The fingers become stiff as a result of adhesions in the tendon sheaths, and the power of opposing the thumb and fingers may be lost. Pain is usually absent until the articular surfaces become carious, and then it is elicited by movement. Softening of the ligaments may result in lateral mobility and sometimes in partial dislocation. Abscess formation may be followed by the formation of sinuses, and infection of the tendon sheaths, especially those in the palm.

The exact localisation of disease in individual bones or joints may be determined by the positions of pain elicited on pressure or movement, by the use of the X-rays, or by the probe when sinuses are present.

*Treatment.*—Conservative measures may be persevered with over a longer period than in most other joints. The forearm, wrist, and metacarpus are immobilised in the attitude of dorsal flexion, while the fingers and thumb are left free to allow of passive movements. It may be necessary to give an anæsthetic to obtain the necessary degree of dorsiflexion. To inject iodoform, the needle is inserted immediately below the radial or the ulnar styloid process. Sometimes the carpal bones are so soft that the needle may be made to penetrate them in different directions. Abscess is treated on the usual lines. Excision of the diseased bones and synovial membrane by a single ulnar incision (Heron Watson) is a satisfactory operation, and usually yields a movable joint. It is indicated in cases which resist conservative measures, or when the general health calls for removal of the disease.

*Other diseases of the wrist* are comparatively rare. They include pyogenic affections such as those resulting from septic conditions in the palm of the hand, different types of gonorrhœal, rheumatic, and gouty affections, and arthritis deformans.

## The Hip-Joint.

Owing to the depth of this joint from the surface, it is not possible to detect the presence of effusion or of synovial thickening as readily as in other joints, hence in the recognition of hip disease we have to rely very largely upon indirect evidence, such as a limp in walking, an alteration in the attitude of the limb, or restriction of the normal movements of the joint. In

examining a case of suspected hip disease, it is necessary to compare the length of the two limbs, to ascertain the position of the great trochanter in relation to Nélaton's line, to recognise the attitude of the limbs in relation to the pelvis, and to note whether or not the pelvis is tilted.

It should be borne in mind that the whole of the anterior and fully one-half of the posterior aspect of the neck of the femur is covered by synovial membrane, so that lesions not only of the epiphysis and epiphysial junction, but also of the neck of the bone, are capable of extending directly to the synovial membrane and to the cavity of the joint. Infective material may escape from the joint into the surrounding tissues through any weak point in the capsule, particularly through the bursa which intervenes between the capsule and the ilio-psoas, and which in one out of every ten subjects communicates with the joint.

**Tuberculous Disease.**—Tuberculous disease of the hip, morbus coxæ, or "hip-joint disease," is especially common in the poorer classes. It is a frequent cause of prolonged invalidism and of permanent deformity, and is attended with a considerable mortality. It is essentially a disease of early life, rarely commencing after puberty, and almost never after maturity.

**Pathological Anatomy.**—Bone lesions bulk more largely in hip disease than is the case in other joints—five cases originating in bone to one in synovial membrane. The acetabulum and upper end of the femur are affected with about equal frequency. Disease originating in the spongy bone in the floor of the acetabulum may spread into the pelvis.

In addition to the primary tuberculous lesions, secondary changes result from pressure of the inflamed and softened bones against one another, subsequent to the destruction of their articular cartilages. The head of the femur undergoes absorption from above downwards, becoming flattened and truncated, or disappearing altogether. In the acetabulum, the absorption takes place in an upward and backward direction, whereby the socket becomes enlarged and elongated towards the dorsum ilii. To this progressive enlargement of the socket Volkmann gave the suggestive name of "wandering acetabulum" (Fig. 259). These secondary changes are of clinical importance, the resulting displacement of the femur being one of the most important causes of real shortening of the limb in advanced cases of hip disease.

**Clinical Features.**—It is customary to describe three stages in the progress of hip disease, but it is to be borne in mind that they merge into one another. The stage of onset is characterised

by a limp, pain, and restriction of the movements of the joint; the second stage, by abduction and apparent lengthening of the limb; and the third stage, by adduction and apparent or actual shortening. The first of these stages may be absent, or may escape observation; the second is typical of hip disease, but may also be absent in acute cases in which sometimes the attitude from the outset is one of adduction. Recovery often occurs before the disease reaches the third stage, or the treatment adopted may prevent the limb assuming the attitude characteristic of this stage. The formation of abscess may take place at any stage.



FIG. 259.—Advanced Tuberculous Disease of Acetabulum with caries and perforation into pelvis.

(Anatomical Museum, University of Edinburgh.)

*Initial Stage.*—At this stage the disease is confined either to the synovial membrane, or to a focus in the bone which has not yet opened freely into the cavity of the joint. The onset is usually very insidious, and if injury is alleged as an exciting cause, some weeks have usually elapsed between the receipt of the injury and the onset of symptoms. In the case of a child, he is usually brought for advice because he has begun to limp and to suffer pain. The statement may be made that he has become pale, that he has ceased to take food well, that his sleep has been disturbed, and that the pain and the limp, after coming and going for a time, have become more continuous and pronounced. On walking, the affected limb is dragged in such a way as to avoid movement at the hip, and to substitute for it movement of the pelvis. The child throws the weight of the trunk as little as possible on to the affected limb, and inclines to rest on the balls of the toes rather than on the heel. There is usually some wasting of the muscles of the thigh and slight flattening of the buttock. Diminution or loss of the gluteal

fold indicates a degree of flexion at the hip which might otherwise escape notice. Pain is complained of in the hip, or is referred to the inner side of the knee in the distribution of the obturator nerve. Sometimes the pain is confined to the knee, and if the examination is restricted to that joint the disease at the hip may be overlooked. At this stage the attitude of the limb is not constant; at one time it may be quite natural, and at another slightly flexed or abducted. Tenderness of the joint may be elicited either in front or behind the head of the bone, but is of little diagnostic importance. Pain elicited on driving the head against the acetabulum may occasionally assist in the recognition of hip disease, but the diagnostic value of this sign has been overrated.

Most information is gained by testing the functions of the joint, and if this is done gently and without jerking, there is no complaint of pain. To reassure the child the movements should be first practised on the sound limb. The child should lie on his back, either on his nurse's knee or on a table. On slowly flexing the thigh of the affected limb, it will be found that the range of flexion at the hip is soon exhausted, and that any further movement in this direction takes place at the lumbo-sacral junction. The child is next made to lie on his face with the knees flexed in order to test the movements of rotation. The thigh is rotated outwards and inwards, and on comparing the two sides it will be found that rotation is restricted or abolished on the side affected, any apparent rotation taking place at the lumbo-sacral junction. These tests reveal the presence of *rigidity* resulting from the involuntary contraction of muscles, which is the most reliable sign of hip disease during the initial stage. This procedure has the advantage of being universally applicable, even in the case of very young children. If there should still exist any doubt as to the presence of hip disease, the examination should be repeated from week to week until a definite conclusion is arrived at.

*Second Stage.*—This probably corresponds with commencing disease of the articular surfaces, and progressive involvement of all the structures of the joint. The patient presents more evident symptoms, and usually exhibits the attitude of abduction, eversion, and flexion (Fig. 260) which, although characteristic of the second stage of the disease, is not constant; as one or other of the abnormal attitudes may predominate or may be entirely wanting.

At first the abnormal attitude is maintained entirely by the

action of muscles; but when it is prolonged, the muscles, fasciæ, and ligaments undergo shortening, so that it becomes fixed.

On looking at the patient the abnormal attitude may not be at once evident, as he usually restores the parallelism of the limbs by lowering the pelvis on the affected side and adducting the sound limb. This obliquity or tilting of the pelvis causes *apparent lengthening* of the diseased limb. It is best demonstrated by drawing one straight line between the anterior iliac



Fig. 260.—Early Tuberculous Disease of Right Hip-joint in a boy æt. 14, showing flexion, abduction, and apparent lengthening of the limb.

spines, and another to meet it from the ensiform cartilage through the umbilicus. If the pelvis is in its normal position, the two lines intersect at right angles; if it is tilted, the angles at the point of intersection are unequal. The flexion of the thigh may be largely compensated for by increasing the forward curve of the lumbar spine (lordosis) and by flexing the leg at the knee. There may also be an attempt to compensate for the eversion of the limb by rotating the pelvis forwards on the affected side. To demonstrate the lordosis the patient should be laid on a flat table; in the resting position, the lordosis is

moderate, when the hip is flexed it disappears, when it is extended the lordosis is exaggerated, and the hand or closed fist may be inserted between the spine and the table (Figs. 261, 262).

When *the functions of the joint* are tested, it will be found that there is rigidity, and that both active and passive movements take place at the lumbo-sacral junction instead of at the hip. While rigidity is usually absolute as regards rotation, it may sometimes be possible with care and gentleness to obtain a little increase of flexion. For diagnostic purposes most stress

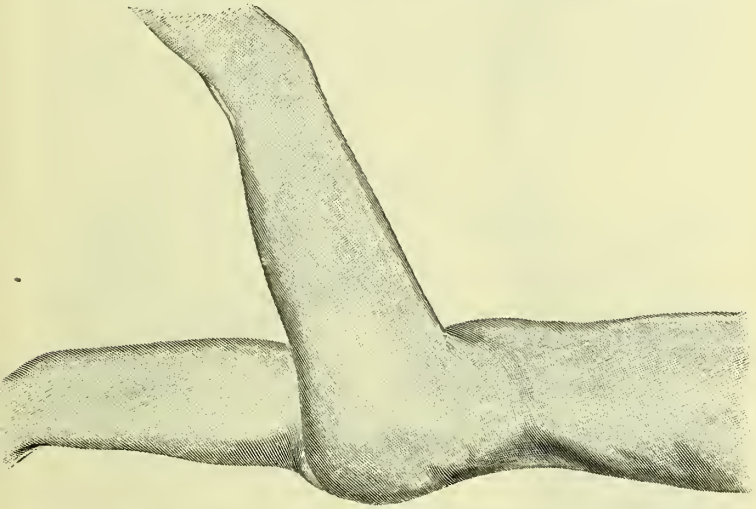


FIG. 261.—Disease of Left Hip—disappearance of lordosis on flexion of the hip.

should therefore be laid on the absence of rotation—for example, if in a patient who exhibits abduction and flexion, while it is possible to elicit rotation movements, the probability is that he is not suffering from disease of the hip-joint but from some affection in its neighbourhood.

The "Thomas flexion test" is founded upon the inability to extend the diseased hip without producing lordosis. By lifting the knee of the sound limb until it touches the chest, the pelvis is fixed and the spine is straightened. If there is flexion deformity, the patient is unable to extend the thigh on the diseased side, and it remains at an angle. If disease is absent the patient can voluntarily extend the limb.

*Swelling* is best detected on the anterior aspect of the joint; when present it may fill up the fold of the groin and project forward the femoral vessels. It is doughy and elastic like the white swelling of other joints, but may at any time liquefy and form a cold abscess. Swelling about the trochanter and neck of the bone may be estimated by measuring the antero-posterior diameter with calipers, and comparing with the sound side. The absence of swelling does not exclude the existence of hip disease, as the lesions may be confined to the interior of the bone. Swelling on the pelvic aspect of the acetabulum may be discovered on rectal examination.

*Third Stage.*—This probably corresponds with advanced caries of the articular surfaces, since pain is now a more prominent feature, and there are usually startings at night. The



FIG. 262.—Disease of Left Hip—exaggeration of lordosis produced by extending the joint.

attitude is one of *adduction*, *inversion*, *increase of flexion*, and *apparent or real shortening of the limb* (Fig. 263). The *flexion* is usually so pronounced that it can no longer be concealed by lordosis, so that when the patient is recumbent, although the spine is arched forwards, the limb is still flexed both at the hip and at the knee; with the spine flat on the table the flexion of the thigh may amount to as much as a right angle. The *adduction* varies greatly in degree; when it is slight, as is most often the case, the toes of the affected limb rest on the dorsum of the sound foot, as in a traumatic dislocation on to the dorsum ilii. When moderate, it is compensated for by raising of the pelvis on the affected side, with *apparent shortening* of the limb (Fig. 264), this being the result of an effort on the part of the patient to restore the normal parallelism of the limbs, the sound limb being abducted to the same extent as

the affected limb is adducted. It is of great importance to recognise the cause of this shortening, as it can be corrected by treatment. As a result of the obliquity of the pelvis, the patient, when erect, exhibits a lateral curvature of the spine with the dorso-lumbar convexity to the sound side.

When adduction is very pronounced, the patient is unable to restore the normal parallelism of the limbs, and the knee on the affected side may cross the sound limb (Fig. 263). There is a deep groove at the junction of the perineum and thigh, there is great prominence of the trochanter, and the pelvis may be tilted to such an extent that the iliac crest touches the lower ribs.

As a result of the pressure of the carious articular surfaces against one another, the upper end of the femur is drawn gradually upwards and backwards within the socket. Examination will then reveal the existence of a variable amount of *actual shortening*; it will also be found that the trochanter is displaced above Nélaton's line, while above and behind the trochanter there is a prominent hard swelling corresponding to the margin of the enlarged acetabulum.

There may, therefore, be a combination of real and of apparent shortening amounting together to several inches.



FIG. 263.—Advanced Tuberculous Disease of Left Hip-joint in a girl æt. 7, showing flexion, adduction, inversion, and shortening.

In cases of long standing, the shortening is still further added to by deficient growth in length of all the bones of the limb.

The most reasonable explanation of the attitudes assumed in hip disease is that given by König. If the patient walks without crutches, as he is usually able to do at an early stage of the disease, the attitude of abduction, eversion, and slight

flexion enables him to save the limb to the utmost extent; on the other hand, if he uses a crutch, as he is obliged to do at a more advanced stage, he no longer uses the limb for support, but draws it upwards and inwards into the position of adduction, inversion, and greater flexion. Similarly, if he is confined to bed he lies on the sound side, and the affected limb sinks by gravity so as to lie over the normal one in the position of adduction, inversion, and flexion. König's explanation accords with the fact that in the exceptional cases which begin with adduction and inversion we have usually to deal with a more severe type of the disease, associated with grave osseous lesions — precisely those cases in which the patient is compelled from the outset to lie up or to adopt the use of crutches. Further, the transition from the abducted to the adducted position is usually associated with such an aggravation of the symptoms that the patient is no longer able to walk without assistance.

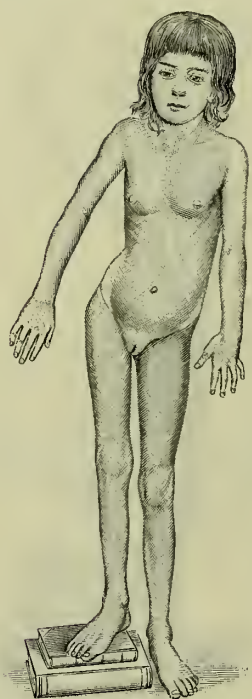


Fig. 264. — Advanced Tuberculous Disease of Right Hip-joint in a girl æt. 10. Adduction compensated for by tilting of pelvis.

During the third stage the other signs and symptoms become more pronounced; the patient becomes pale and thin; he is usually unable to leave his bed; his sleep is disturbed by startings of the limb; and the rigidity of the joint and the wasting of the muscles are very marked. The temperature may rise slightly after examination of the limb, or after a railway journey, or from abscess formation. Marked elevation of the temperature, apart from septic complications, usually indicates the development of tubercle elsewhere, or of general tuberculosis.

**Abscess Formation in Hip Disease.** — The formation of abscess is not related to any particular stage of the disease. It may occur before there is any deformity, or it may be deferred until the disease has apparently recovered. Its chief import-

ance lies in the fact that if a mixed infection with pyogenic organisms occurs the gravity of the condition is greatly increased, the patient being exposed to all the risks of septic poisoning.

An abscess may appear *in the thigh* in front of or behind the joint.

The *anterior abscess* usually comes to the surface on one or other side of the psoas muscle. From the resistance offered by the fascia lata, the pus may gravitate down the thigh before perforating the fascia and pointing. It has occasionally happened that when such an abscess has been opened and become septic, the femoral vessels have been eroded, and serious or even fatal hæmorrhage has resulted. The *posterior abscess* develops in the gluteal region, and may make its way to the surface through the gluteus maximus; more often it points at the lower border of this muscle in the region of the great trochanter, or it may gravitate down the thigh.

Abscesses which form *within the pelvis* originate either in connection with the acetabulum or in relation to the psoas muscle where it passes in front of the joint. Those which are directly connected with disease of the acetabulum may remain localised to the lateral wall of the pelvis, or may spread backwards towards the hollow of the sacrum. They may open into the bladder or rectum, or may ascend into the iliac fossa and point above Poupart's ligament, or descend towards the ischio-rectal fossa. The abscess which develops in relation to the psoas muscle may be shaped like an hour-glass, one sac occupying the iliac fossa, the other filling up Scarpa's triangle, the two sacs communicating with each other through a narrow neck beneath Poupart's ligament.

So long as the skin is unbroken the abscess is unattended with fever or pain. If the abscess bursts externally septic infection is almost inevitable, and if the opening is insufficient for drainage, there occur repeated attacks of inflammation attended with fever, burrowing of pus, and the formation of fresh sinuses. The patient gradually passes into the condition of hectic fever or chronic septic poisoning; he loses ground from day to day, may become the subject of waxy disease in the viscera, or may die of exhaustion, tuberculous meningitis, or general tuberculosis. The presence of septic sinuses is not incompatible with recovery, but these are a source of danger to which the patient should not be exposed if he comes under treatment with unbroken skin.

**Dislocation** is a rare complication of hip disease and is most likely to occur during the stage of adduction with inversion.

It has been known to take place during sleep from spasmodic contraction of muscles. In dorsal dislocation, which is the most common form, adduction and inversion are pronounced, the trochanter projects above and behind Nélaton's line, and the head of the bone may be felt on the dorsum ilii. It is a striking fact that after dislocation has occurred there is less complaint of pain or of startings than before, and passive movements may be carried out which were previously impossible.

**Diagnosis of Hip Disease.**—The diagnosis is to be made not only from other affections of the joint itself, but also from morbid conditions in the vicinity of the hip, as in any of these the patient may seek advice on account of pain and a limp in walking. The patient should be stripped, and if able to walk, his gait should be observed. He is then examined lying on his back, and attention is directed to the comparative length of the limbs, to the attitude of the limbs and pelvis, and to the movements at the hip-joint, especially those of rotation. When there is any doubt as to the diagnosis, the examination should be repeated at intervals of a week or ten days. In children, there are three non-febrile conditions attended with a limp and with shortening of the limb, which may be mistaken for hip disease—*congenital dislocation*, *coxa vara*, and *infantile paralysis*—but in all of these the normal movements are less restricted than in disease of the joint, and the history is different.

In tuberculous disease of the *sacro-iliac joint*, while the pelvis may be tilted, and the limb apparently lengthened, the movements at the hip are retained. In tuberculous disease of the *great trochanter*, or of either of the bursæ over it, the resemblance to hip disease is very close, there may be abduction, eversion, impairment of mobility, and swelling in the region of the trochanter followed by abscess formation, but the movements are less restricted than in disease of the joint.

In *psoas abscess* associated with spinal disease, or in disease of the bursa underneath the psoas, the limb is flexed and everted, there may be lordosis, and the patient may walk with a limp. The movements at the hip are restricted only in the directions of extension and inversion, while in hip disease they are restricted in all directions.

New growths in the vicinity of the hip—especially commencing sarcoma of the upper end of the femur—may be very difficult to differentiate from hip disease. In sarcoma there is no rigidity at the joint, and skiagrams usually give definite information.

Among other conditions which may simulate hip disease, especially in children, are appendicitis, inflammation of the glands in the groin, staphylococcal disease of the upper end of the femur, and sciatica.

The diagnosis *from other diseases of the hip-joint* is seldom difficult.

*Prognosis.*—The prognosis in hip disease is more serious than in tuberculosis of other joints, excepting only those of the spine, and it is most unfavourable where there are gross lesions of the bones and infected sinuses, especially in adults who are the subjects of tuberculosis elsewhere, although even these cases may eventually recover.

Whatever the stage of the disease, recovery is a slow process, and even in early and mild cases it seldom takes place in less than two years, and is liable to be attended with some impairment of function. During the process of cure complications are always liable to occur, and after apparent recovery relapses are not uncommon. When arrested during the initial stage, there may only be a limitation in the range of movement; but when the disease has advanced to the stage in which there is destruction of the articular surfaces, the joint is liable to become ankylosed and the limb may be shortened. The average shortening amounts to from one and a half to two inches. The formation of abscess, especially within the pelvis, is a serious complication.

In cases which terminate fatally, death usually results from meningeal, pulmonary, or general tuberculosis, septic complications, and waxy degeneration.

**Treatment.**—A large proportion of cases recover under conservative treatment, and the functional results are so much better than those following operative interference, that unless there are special indications to the contrary conservative measures should always be adopted in the first instance.

*Conservative Treatment.*—This consists in protecting the limb from injurious strain or pressure, and in preventing deformity. Absolute rest is imperative, and the patient must be confined to bed until pain and tenderness have disappeared and sleep is undisturbed.

*Extension by means of weight and pulley* is of most service in cases attended with pain, spasmodic contraction of muscles, rigidity of the joint, or a deformed attitude of the limb. The weight employed varies from three to eight pounds in children, to ten or more pounds in adolescents and adults, and must be adjusted to meet the requirements of each case. If pain returns

after having been relieved, it is due to overstretching of the ligaments, and the weight should be diminished or removed for a time. If there is deformity, the line of traction should at first be in the axis of the deformed limb, and later should gradually be brought into the normal axis. Flexion yields most readily. If there is abduction, extension should be applied to both limbs, and if there is adduction it may be necessary to apply counter-extension by means of a perineal band. The attitude ultimately desired is one of almost complete extension with slight abduction.

When the *deformed attitude does not readily yield to extension*, there is considerable advantage in correcting it by forcible manipulations carried out under anæsthesia; but if the tendons and fasciæ are so contracted that this is impossible they should be divided.

In restless children, to ensure absolute rest in the attitude of extension and slight abduction, additional means may be necessary; a long splint applied on the sound side, and a heavy sand-bag on the affected side; or, better still, a double long splint and cross-bar. The long splint on the affected side is made with a hinge opposite the hip-joint, to permit of varying the degree of abduction. Any tendency to rotation may be obviated by strips of strong adhesive plaster, wrapped round the thigh in a direction opposed to that of the rotation, and fixed to the long splint or sand-bag.

Treatment by extension and the long splint should be continued until pain, tenderness, and muscular contraction have disappeared, and the limb has been brought into the attitude of slight abduction. The joint must be kept at rest, and the affected limb is not allowed to touch the ground. In children who are unable to use crutches, a double Thomas' splint, a Phelp's box, a Bonnet's wire cuirass, or plaster of Paris is employed. By using any of these appliances the child is converted into a rigid object, capable of being carried about from one room to another or into the open air. Personally, we have obtained the best results from the double Thomas' splint, like that used for spinal disease, which extends from the occiput to the feet.

*Ambulant Treatment.*—When the patient is able to use crutches, the affected limb is prevented from touching the ground by fixing a patten to the sole of the boot on the sound side. The hip-joint is kept rigid in the abducted position by a Thomas' (Fig. 265) or a Taylor's splint, or by a case of plaster of Paris. The plaster is used chiefly in hospital out-patients

who cannot be kept under continual supervision. It may be strengthened by broad strips of aluminium, and should be renewed at intervals of from six weeks to three months. The treatment is continued for some months after all symptoms have disappeared. If at any time there is a return of active



Fig. 265.—Thomas' Hip-splint applied. Note patten under sound foot.

symptoms, the patient must again lie up with extension applied to the limb.

*Counter-irritation* by means of the actual cautery applied over the great trochanter may give considerable relief when there is much pain in the persistent hip disease of adults.

*Treatment of Abscess.*—The early recognition and prompt treatment of abscess before it has spread widely or is threatening to rupture externally, has greatly reduced the suffering and mortality from hip disease. The methods of treatment are the same as are employed in other joints. If an open operation is

adopted, the opportunity may be taken of dealing with any extra-articular bone lesion at the same time.

*Operative interference* is indicated—1. When the disease is progressing rapidly, or is advancing in spite of conservative treatment. 2. When it relapses after apparent cure, and is attended with suppuration. 3. When, along with evidence of persistence of the disease, there is a deformed attitude which does not yield to extension or correction under anæsthesia, or when there is dislocation of the head of the femur, or separation of its upper epiphysis. 4. When there is an abscess within the pelvis, or other evidence of disease of the acetabulum. 5. When there are septic sinuses and persistent discharge with symptoms of hectic and of waxy degeneration. These last are most unfavourable cases whether an operation is performed or not; at the same time, operation, if it is not too long delayed, may afford the only chance of recovery. 6. In adults who show no signs of recovery within a year from the onset of the disease. This indication specially refers to "bread-winners," in whom it is specially urgent that they should be able to resume work. In children there is no urgency for resuming active life, the prospects of spontaneous recovery are considerable, and an operation may interfere with the subsequent growth of the limb.

*Nature of the Operative Interference.*—As operation must often be undertaken without a definite knowledge of the exact condition of matters within and around the joint, we are frequently unable to decide beforehand the extent of the operation which is required. Our object should be to expose the disease wherever situated, and to remove it with the least possible damage to the normal structures. The more open the method of operation the better, since more reliable information is obtained by inspection than by palpation. These indications are best fulfilled by the operation devised by Kocher, which, by permitting of dislocation of the femur, affords free access to all parts of the joint. Tuberculous synovial membrane is removed with the scissors and sharp spoon. If it should be found that the disease in the head of the bone is limited to the surface or to isolated areas, it may be got rid of with the spoon or gouge, thus preserving the head, which is returned to the acetabulum. This procedure, which may be described as an *arthrectomy*, should be practised whenever possible. If, on the other hand, the head and neck of the bone are more extensively diseased, the neck is divided with a wire saw or a chisel, and the diseased portion is removed. The disease in the acetabulum and soft parts having been dealt

with, the raw surface of the neck is implanted in the socket. This operation constitutes an *excision* of the joint.

After either of these operations the limb is fixed in an attitude of marked abduction, so that when the patient resumes the erect posture, in order to restore the parallelism of the limbs he will be obliged to depress the pelvis on the affected side, and will so compensate, in part at least, for the shortening caused by the operation.

*Amputation* for tuberculous disease of the hip has become one of the rarest operations of surgery, but is still required in cases which have continued to progress after excision, when there is disease of the pelvis or of the shaft of the femur, with septic sinuses, albuminuria, and hectic fever. In such cases the surgeon must be prepared not only to disarticulate at the hip-joint, but also to remove a portion of, or the entire innominate bone. Such extensive operations are usually carried out by some form of racket incision, which permits of the ligature of the main vessels as a preliminary measure.

**The Correction of Deformity resulting from Antecedent Disease of the Hip.**—From neglect or from improper treatment, the deformities already described may have been allowed to persist, while the joint disease has recovered. They are associated either with ankylosis of the joint, or with contracture of the soft parts, or with a combination of these conditions. The contracture of the soft parts involves specially the tendons, fasciæ, and ligaments on the anterior and inner aspects of the joint, and is usually present to such a degree that, even if the joint were rendered mobile, these shortened structures would prevent correction of the deformity. It should be borne in mind that the difficulties of correction are so considerable that it should not be attempted unless the deformity is a serious hindrance to locomotion or a bar to remunerative occupation. The deformity most often present consists in a combination of shortening, flexion, and adduction.

If flexion is the prominent feature, it may be corrected by performing an osteotomy through the neck of the femur (Adam's operation), or through the trochanter if the neck of the bone has disappeared. The contracted soft parts are divided, either by subcutaneous or by open tenotomy, after which the limb is extended and abducted. In a patient whose occupation entails the sitting posture it may not be an advantage to correct flexion.

If adduction and inversion are the prominent features, the choice lies between a transverse osteotomy below the lesser trochanter (Gant's operation), an oblique osteotomy from above

downwards and inwards, through the great trochanter, or a resection of the joint, according to the special features of the case. If necessary the adductor muscles, fascia lata, and other contracted soft parts are divided by subcutaneous or open tenotomy. The limb is then forcibly abducted and extended, and maintained in this position by extension with the weight and pulley, and by the double long splint already described.

**Bilateral Hip Disease.**—Both hip-joints may become affected with tuberculous disease, either simultaneously or successively, and abscesses may form on both sides. The patient is necessarily confined to bed, and if the disease is recovered from, his capacity for walking may be seriously impaired, especially if the joints have become fixed in an undesirable attitude. The most striking deformity occurs when both limbs are adducted so that they cross each other,—the "scissor-leg" or "crossed-leg" deformity—in which the patient, if able to walk at all, does so by forward movements from the knees. An attempt should be made to secure a movable joint at least on one side.

**Pyogenic Diseases.**—This group includes a number of conditions resulting from infection of the joint with the common pyogenic organisms, or with the gonococcus, or the typhoid bacillus. While the organisms usually gain access to the tissues of the joint through the blood-stream, a direct infection is occasionally observed from suppuration in the femoral lymphatic glands or in the bursa under the ilio-psoas. The pyogenic diseases are met with chiefly in childhood and youth.

The *clinical features* are sometimes much less striking than might be expected, and are remarkably latent when the hip affection occurs as a complication of some general illness such as scarlet fever. The affection is sometimes entirely overlooked during its active stage, and only at a later period is the head of the femur found to be dislocated, or the joint found to be ankylosed. In the acute arthritis of infants also the clinical features may be comparatively mild, but as a rule they assume a type in which the suppurative element predominates. The limb usually becomes flexed and adducted, and a swelling forms in front of the joint at the upper part of Scarpa's triangle. The head of the bone may be dislocated or the upper femoral epiphysis detached. The gonorrhœal affections resemble those in other joints.

In pyogenic affections, such as may attend typhoid and other fevers, the flexion and adduction of the limb favours the occurrence of dislocation at the hip. In the case of a child who has recovered with dislocation on to the dorsum ilii, he is

usually able to walk and run about, but with a limp which becomes more pronounced as he grows up. The appearances closely resemble those of congenital dislocation, and unless an accurate history is obtainable, it may be impossible to distinguish between them.

*Treatment.*—The limb is extended by means of the weight and pulley, and kept at rest with the single or double long splint, or by means of sand-bags. If there is evidence of suppuration, the joint should be explored by an anterior incision inclining downwards and inwards from the anterior superior iliac spine between the tensor fasciæ femoris and the sartorius; a posterior opening being made for drainage. In children, it is remarkable how completely the joint may recover under this method of treatment.

If there is dislocation of the femur, it should be reduced by manipulation with or without preliminary extension; it has been successful in about one-half of the cases in which it has been attempted. Preliminary tenotomy of the shortened tendons is required in some cases. When reduction by manipulation is impossible, the joint structures should be exposed by one or other of the methods employed in excising the joint, and the head of the bone, if present, replaced in the acetabulum; in the absence of the head, the neck should be fixed against the socket, thereby diminishing shortening at the expense of mobility.

**Arthritis Deformans.**—This disease is comparatively common at the hip, either as a monarticular affection or simultaneously with disease of other joints.

*The changes in the joint* are characteristic of the dry form of the disease, and affect chiefly the cartilages and bones. The atrophy and wearing away of the articular surfaces are accompanied by a new formation of cartilage and bone around their margins. The head of the femur may acquire the shape of a helmet, a mushroom, or a limpet shell. From absorption taking place in the neck of the femur, the head may come to be sessile at the base of the neck, and may occupy a level considerably below that of the great trochanter (Fig. 266). These changes may extend to the upper part of the shaft of the femur, and result in curving of the shaft and neck, suggesting a resemblance to a point of interrogation. The acetabulum may "wander" backwards and upwards, as in tuberculous disease. It is usually deepened, and its floor may project on the pelvic aspect; its margins may form a projecting collar which overhangs the neck of the femur, or grasps it so that, even in the macerated condition, the head is imprisoned in the socket and

the joint locked. There is eburnation of the articular surfaces similar to that seen in other joints.

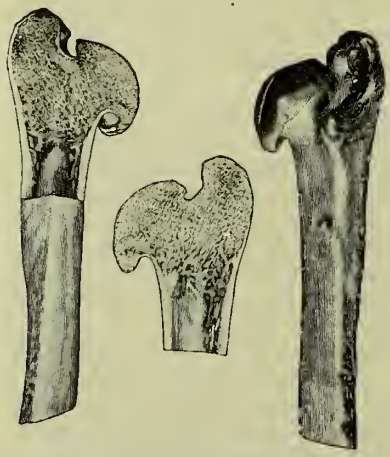


Fig. 266.—The Upper End of the Femur in advanced Arthritis Deformans of Hip, showing absorption of neck and downward displacement of head of bone.

(Museum of Royal College of Surgeons, Edinburgh.)

These changes are necessarily associated with great restriction of the movements of the joint, and with striking deformity, which consists in shortening of the limb, usually with eversion and displacement of the trochanter upwards and backwards in relation to Nélaton's line.

The *clinical features* are usually so characteristic that there is little difficulty in diagnosis. Restriction of the movements of abduction and adduction, the presence of cracking and of grating of the articular surfaces, and the aggravation of the pain and stiffness after resting the limb, are characteristic of arthritis deformans. The prominence of sciatic pain may lead to the disease being regarded as sciatica.



Fig. 267.—The Upper End of the Femur in advanced Arthritis Deformans of Hip. The shaft is curved, and the head of the bone is at a lower level than the great trochanter.

(Anatomical Museum, University of Edinburgh.)

The greatest difficulty is met with in cases where the disease occurs as a monarticular affection in early life, for the resemblance to tuberculous disease of the hip and to coxa vara may be very close. Skiagrams do not always aid in differentiating between them.

The local *treatment* is for the most part palliative, and consists in attempting to maintain the normal movements of the joint,

and to diminish the pressure on the articular surfaces by the use of sticks or crutches in walking. Shortening of the limb may be compensated for by wearing a high boot. Forcible movements of the joint under an anæsthetic do more harm than good. Excision of the joint has in some cases yielded satisfactory results; it is indicated in young patients who are otherwise healthy, and who are unable to walk on account of pain and deformity. The general treatment of arthritis deformans must also be carried out.

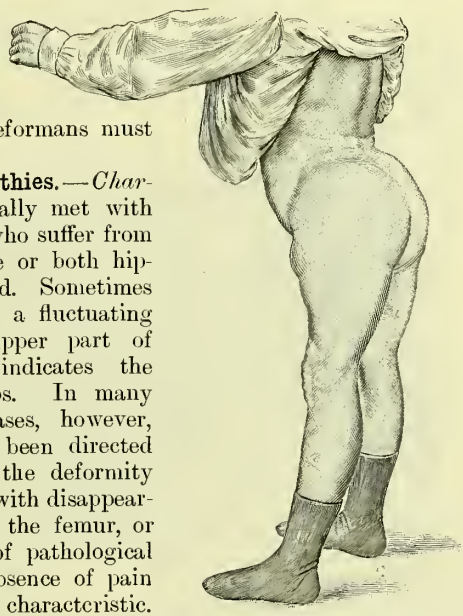


Fig. 268. — Bilateral Charcot's Disease of Hip, with dislocation of head of femur on to dorsum ilii.

(Dr. H. G. Langwill's case.)

**Neuro-Arthropathies.** — *Charcot's disease* is usually met with in men over thirty who suffer from tabes dorsalis. One or both hip-joints may be affected. Sometimes the development of a fluctuating swelling in the upper part of Scarpa's triangle indicates the presence of hydrops. In many of the recorded cases, however, attention has first been directed to the disease by the deformity and limp associated with disappearance of the head of the femur, or by the occurrence of pathological dislocation. The absence of pain and tenderness is characteristic. When dislocation has occurred, the limb is short, and the upper end of the femur is freely movable on the dorsum ilii. When both hips are dislocated (Fig. 268) the attitude and gait are similar to those observed in bilateral congenital dislocation. The rotation arc of the great trochanter may be much reduced as a result of the disappearance of the head of the femur. There may be considerable formation of new bone, giving rise to large tumour-like masses in relation to the capsular ligament and the muscles surrounding the joint.

The *treatment* consists in protecting and supporting the joint. When the affection is unilateral, advantage may be derived from a Thomas' or other form of splint, along with a

patten and crutches; in bilateral cases, from the use of crutches alone.

*Hysterical affections* of the hip are also met with.

## The Knee-Joint.

The knee is more often the seat of disease than any other joint in the body.

The synovial membrane of the knee extends beneath the quadriceps extensor as a cul-de-sac, which either communicates with the subcrural bursa, or with it forms one continuous cavity (Fig. 188). When the joint is distended with fluid, this upper pouch bulges above and on either side of the patella, and this bone is "floated" off the condyles of the femur. When there is only a small amount of fluid in the knee, it is most easily recognised while the patient stands with his feet together and the trunk bent forwards at the hip-joints, the complete relaxation of the quadriceps allowing the fluid to bulge above and on each side of the patella, where its presence is readily detected, especially on comparison with the joint of the other side.

On account of the great extent of the synovial membrane, a large quantity of serous effusion may accumulate in the joint in a comparatively short time, as a result either of injury or disease. The villous processes and fringes may take on an exaggerated growth, and give rise to pedunculated and other forms of loose body.

The bursæ in the popliteal space, and especially that between the semi-membranosus and the inner head of the gastrocnemius, as well as the subcrural bursa, frequently communicate with the synovial cavity of the knee and may share in its diseases.

The epiphyses at the knee are chiefly responsible for the growth in length of the lower extremity, and are late in uniting with their respective shafts. Serious shortening of the limb, therefore, may result if their functions are interfered with by disease or injury. The epiphysial cartilages lie beyond the limits of the synovial cavity, so that infective lesions at the ossifying junctions are less likely to spread to the joint than is the case at the hip or shoulder, where the epiphyses lie partly or wholly within the joint; disease in the lower end of the femur is more likely to implicate the knee-joint than disease in the upper end of the tibia.

### Tuberculous Disease.

While specially common in childhood and youth, tuberculous disease of the knee may occur at any period of life, and is not uncommon in patients over fifty. The frequency with which the disease originates in the synovial membrane and in the bones respectively would appear to be about equal.

When the synovial membrane is diseased, it tends to grow inwards over the articular surfaces (Fig. 269). In the femur this usually takes place from the lateral margins of the condyles at the level of the lower edge of the patella, often shutting off

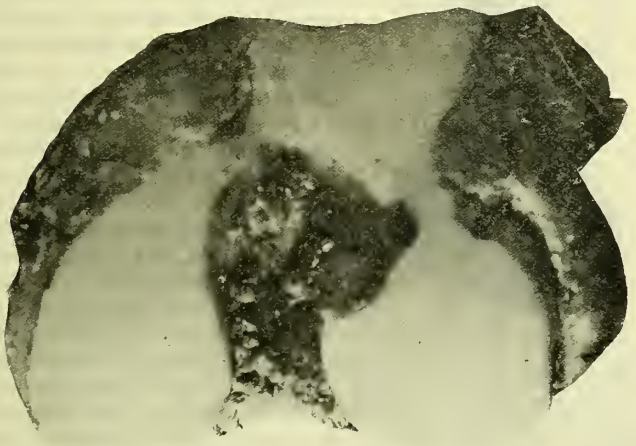


Fig. 269. — Tuberculous Synovial Membrane of Knee, spreading over articular surface of femur.

the supra-patellar pouch and fixing the knee-cap to the femur. In the tibia and patella the synovial membrane grows in from the margins, diminishing the area of their articular surfaces. The ingrowth of synovial membrane may fill up the entire cavity of the joint, or may divide it up into compartments, one usually being above the patella, and two in relation to the condyles of the femur. When, under these conditions, a tuberculous focus in the bone erupts into the joint, the infection may be confined to one or other of these compartments. Ulceration of the cartilage and caries of the articular surfaces are brought about in the same way as in other joints.

The nature and seat of the bone lesions are subject to the same wide variations as in other joints; the tibia and femur are affected with about equal frequency. Multiple small foci may be found beneath the articular cartilage of the tibia, or along the lateral margins of the femoral condyles—especially the internal. Caseating foci are comparatively rare, but they sometimes attain a considerable size—especially in the head of the tibia, where they may assume the character of a caseous abscess. Sclerosed foci, which may form sequestra, are comparatively common (Fig. 270). Diffuse caseating osteomyelitis may involve an entire epiphysis and extend into the adjacent shaft.



FIG. 270.—The Lower End of Femur from an advanced case of Tuberculous Arthritis of the Knee. Towards the posterior aspect of the internal condyle there is a wedge-shaped sequestrum, of which the surface exposed to the joint is polished like porcelain.

(Anatomical Museum, University of Edinburgh.)

**Clinical Types of Tuberculous Disease of the Knee.**—(1) *Hydrops tuberculosis* is that type in which the outstanding feature is the accumulation of fluid in the joint (Fig. 271). It usually arises from a purely synovial lesion, but when the joint suddenly becomes distended with fluid, it may depend on foci in the bones.

It is met with chiefly in young adults. As a rule, the fluid accumulates gradually and imperceptibly, stretching the capsule, and pushing the patella forwards, so that it floats. There is little pain or interference with the functions of the joint; the patient is usually able to walk, but is easily tired. The amount of fluid diminishes under rest, and increases after use of the limb. In a certain number of cases it may be possible to recognise some thickening of the synovial membrane, or the presence of friction or crepitation from the mutual contact of floating masses of fibrin or melon-seed bodies. This is best appreciated if the knee is alternately flexed and extended by the patient while the surgeon grasps and compresses it with both hands. If the joint is opened, fibrinous material, often in the form of melon-seed bodies, may be found lining the synovial membrane and partially covering the articular surfaces. Melon-seed bodies may be found in the fluid withdrawn from the joint.

Tuberculous hydrops is to be diagnosed from the effusion which results from sprain, from the hydrops of gonorrhœa, arthritis deformans, Charcot's disease, and Brodie's abscess in an adjacent bone, and from the hæmarthrosis met with in bleeders. Given a patient, and especially a young adult with fluid in the knee, and having excluded injury, it is most likely due either to tuberculosis or to gonorrhœa. The presence of melon-seed bodies is confirmatory of the diagnosis of tubercle.

Tuberculous hydrops is specially amenable to conservative treatment by rest and by injections of iodoform. Relapse, however, is not uncommon, and experience shows that if the disease is neglected, there may be a gradual transition from an innocent hydrops to the graver types of synovial tuberculosis.

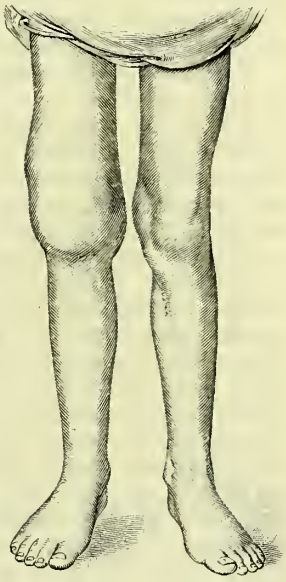


Fig. 271.—Tuberculous Hydrops of Knee with distension of subcrural bursa.

(2) *Papillary or Nodular Tubercle of the Synovial Membrane.*—This may be employed as a clinical term to distinguish a condition in which there is a fringy, papillary, or polypoidal growth from the synovial membrane. It is most often met with in adult males between the ages of twenty and forty. The onset and progress are gradual, and the chief complaint is of stiffness and swelling which are worse after exertion. Sometimes there are symptoms of loose body, such as occasional locking of the joint, with pain and inability to extend the limb; but the locking is easily disengaged, and the movements are free again. The patient may give a history of several years partial and intermittent disability, with lameness and occasional locking, although he may have been able to go about or even to continue his occupation.

There is a moderate degree of effusion into the joint, and when this has subsided under rest it may be possible to feel ill-defined cords, or tufts; or nodular masses, and to grasp between the fingers those in the supra-patellar pouch. There is little wasting of muscles, and it is quite exceptional to

observe any symptoms of implication of the articular surfaces or of the formation of a cold abscess.

On opening the joint, there may escape fluid and loose bodies similar to those described under hydrops, and if the finger is introduced into the cavity, the upper pouch may be felt to be occupied by fringes or polypoidal processes derived from the synovial membrane.

The diagnosis is to be made from arthritis deformans, and in some cases from loose body of other than tuberculous origin.

The treatment specially applicable to this type is to remove the diseased synovial membrane.

(3) *Cold abscess or empyema* of the knee is a rare condition, in which the joint becomes filled with pus. It usually results from a primary tuberculosis of the synovial membrane occurring in those who are much reduced in health, and who are the subjects of tuberculosis elsewhere. While usually insidious in its development and progress, an acute form attended with fever may be met with in children. The treatment consists in withdrawing the pus, and in injecting iodoform into the joint.

(4) *Diffuse Thickening of the Synovial Membrane—White Swelling.*—When this type of disease remains confined to the synovial membrane, the chief clinical feature is that of an indolent elastic swelling in the area of the joint. The swelling tapers off above and below, so that it acquires a fusiform shape, and on account of wasting of the muscles it appears greater than it really is. The range of movement is restricted. The patient limps, keeps the knee slightly flexed, and complains of tiredness and stiffness after exertion.

As time goes on, the articular surfaces become affected and more severe symptoms ensue. There is pain, which is readily excited by jarring of the limb or by any attempt at movement; there may be startings at night which interfere with sleep; and the joint is held rigid. If untreated, flexion becomes more pronounced—it may be to a right angle—the leg and foot are rotated outwards, and, in children, the tibia may be displaced backwards. The wasting of muscles continues, the part becomes hot to the touch, the swelling increases, and may show areas of softening or fluctuation from abscess formation.

White swelling is to be differentiated from peri-synovial gummata, from sarcoma of the lower end of the femur, and from bleeder's knee. In the first of these the swelling is nodular and less uniform, and there may be tertiary ulcers or depressed scars in the neighbourhood of the patella. In sarcoma, the swelling is more marked on one side of the joint,

it is uneven or nodular, it does not correspond to the shape of the synovial membrane but may extend beyond the limits of the joint, and it involves the bone to a greater extent than is usual in cases of joint disease. Skiagrams show expansion of the bone in central tumours, or abundant new bone in cases of ossifying sarcoma. In difficult cases recourse should be had to exploratory incision. The diagnosis of bleeder's knee is to be made chiefly from the history.

(5) *Primary Tuberculous Disease in the Bones of the Knee.*—So long as the foci are confined to the interior of the bone it is usually impossible to recognise their existence, unless they are of sufficient size to cause enlargement of the bone or to be recognisable in a skiagram.

(*a*) If the focus reaches the surface of the bone outside the limits of the synovial membrane, there is tenderness on pressure, pain in walking and probably a limp, and a cold abscess may develop. The joint, although perhaps a little sensitive and restricted in its movement, and in some cases the seat of a serous effusion, may not itself become infected with tubercle.

(*b*) If the focus reaches the surface of the bone at the level of the reflection of the synovial membrane, the membrane becomes thickened at the site of infection in the first instance, but as time goes on, it becomes infected throughout, just as in primary synovial disease. The clinical features are similar to those described under the head of diffuse thickening of the synovial membrane—only they are apt to be more severe and to progress more rapidly, and to be associated with abscess formation in the vicinity of the osseous focus.

(*c*) If the focus reaches the surface of the bone where it is covered by articular cartilage, the latter is perforated or detached, and the joint becomes infected. The symptoms vary with the nature of the perforation and the amount of infective material thrown into the joint. The resulting joint disease may evolve gradually and assume the characters of a dry arthritis, with pain, rigidity, and tendency towards fibrous ankylosis, or it may develop suddenly and progress rapidly towards suppuration and disorganisation of the joint. Tuberculous disease, attended only with symptoms of involvement of the articular surfaces, is to be differentiated from arthritis deformans and from hysterical knee.

**The formation of extra-articular abscess** in tuberculous disease of the knee takes place in rather more than fifty per cent of cases. Abscesses may originate in the substance of the synovial membrane, within the synovial cavity or in one of its compartments, in the surrounding cellular tissue, or in relation

to one of the bursæ in the popliteal space. When left to themselves, such abscesses tend to spread up the thigh, or down the back of the leg between the superficial and deep layers of calf muscles, and numerous sinuses may result from their rupture through the skin.

**Deformed Attitudes in Knee-joint Disease.**—The attitude most often assumed is that of flexion, with or without external rotation of the leg and foot. The occurrence of flexion is explained by its being the resting attitude of the joint, and that which affords most ease and comfort to the patient. Once the joint is flexed, the involuntary contraction of the flexor muscles maintains the attitude, and if the patient is able to use the limb in walking, the weight of the body is a powerful factor in increasing it. The external rotation of the leg is probably associated with contraction of the biceps muscle. Backward displacement of the tibia is met with chiefly in neglected cases of chronic disease of the knee when the patient has walked on the limb after it has become flexed.

In certain cases genu valgum or abduction of the leg is present along with a slight degree of flexion. The valgus attitude is associated with slight outward displacement of the patella, with prominence and apparent enlargement of the internal condyle, with depression of the pelvis on the diseased side and apparent lengthening of the limb.

**Treatment.**—Conservative measures are indicated where there is a prospect of obtaining a movable joint. When the articular surfaces are so involved that this is no longer possible, it is usually both a waste of time and a source of danger to the patient to persist with conservative measures. By means of operation one may anticipate cure of the disease within a definite time, and although the knee is stiff, the limb is a useful one. In children, it is seldom necessary to have recourse to operative measures, because they have greater recuperative powers, and because time is of secondary importance; moreover, extensive operations on the bones tend to interfere with the growth of the limb.

The methods of carrying out *conservative treatment* are similar to those employed in other joints. The limb is immobilised in the position of almost complete extension. If the joint is sensitive and tends to be flexed, the patient is confined to bed, the limb secured to a posterior splint, and extension with the weight and pulley applied to the leg. If there is no pain or tendency to flexion, or when these have been overcome, the limb is put up in a Thomas' splint (Fig. 272) and the

patient allowed to go about. The splint is removed at intervals to allow of examination of the joint, for washing and douching of the limb, and, at a later period, for movement, massage, and electrical stimulation of the atrophied muscles. The splint is worn for a period varying from six to twelve months; before



FIG. 272.—Thomas' Knee-splint applied. Note extension strapping applied to affected leg, and patten under sound foot.

being discarded altogether it may be left off at night; it is ultimately replaced by an elastic bandage.

Treatment by venous congestion, and the injection of iodoform, may in some cases be advantageously added to that by rest. The needle of the syringe is introduced either into the upper pouch or into the interval between the bones on the inner side of the ligamentum patellæ.

The treatment of abscess and of extra-articular foci in the bones is carried out on the same lines as in other joints.

The indications for *operative treatment* are:—(1) Marked symptoms of destruction of the articular cartilages; (2) a deformed attitude incapable of being rectified without operation; (3) a condition of the general health which requires that the disease should be got rid of by the most rapid method; (4) progress or persistence of the disease in spite of conservative treatment; (5) relapse of the disease after apparent cure.

In patients under fifteen years of age, the operation of arthrectomy is to be selected. It consists in removing the tuberculous synovial membrane, and, if the articular surfaces are affected, paring them with a strong knife. Above the age of fifteen, the joint is excised; the ends of the bones are removed with the saw, and diseased soft structures with the knife or scissors.

Amputation is performed irrespective of age when the disease has relapsed after operation with persistent suppuration, and when life is threatened by the occurrence of tuberculosis in the lungs or elsewhere.

**Treatment of Deformities resulting from Antecedent Disease of the Knee.**—When the articular surfaces are fairly preserved, and the flexion is due to contracture of the posterior part of the capsule and other structures in the popliteal space, these should be divided through an oblique incision made from above downwards across the space. If forcible correction is attempted without cutting, it must be carried out in stages. When there is fibrous or osseous ankylosis in the flexed position, and no hope of a movable joint, a more extensive operation is necessary. In adults this consists in removing a wedge of bone. In patients who are still growing, it may be possible to straighten the limb by a modified arthrectomy and the removal of a thin slice of bone, or by dividing the femur above the joint. The alternative is to wait until the patient is nearly fully grown, and then remove a wedge of bone.

**Pyogenic diseases** result from infection through the blood-stream, from the spread of infection from one of the adjacent bones, or from a penetrating wound of the joint. The clinical features, while varying in acuteness and severity, always include well-marked local signs, effusion into the synovial cavity being a prominent and easily recognised feature. The commoner types include the serous synovitis associated with disease in the adjacent bone, acute arthritis of infants, joint suppuration in pyæmia, septic arthritis following upon penetrating wounds, and the affections which result from gonorrhœal or pneumococcal infection.

The *treatment* is directed to meet the features of each individual case. The limb is immobilised on a posterior splint. If it is proposed to tap the joint, the needle should be introduced obliquely into the supra-patellar pouch. If it is necessary to open and drain the joint, the incision is made on one or on both sides of the patella. Even then the infection may continue to progress and threaten the life of the patient, and under these conditions the best procedure is to lay the joint freely open from side to side by dividing the patellar ligament and capsule; the limb is flexed, the whole wound left open and packed with gauze. As the infection subsides, the limb is gradually straightened. It is sometimes necessary to make additional incisions over the back of the condyles to drain the large synovial pouches which lie behind the crucial ligaments. If these methods fail, amputation through the thigh is to be had recourse to.

**Arthritis deformans** may affect the knee alone or in combination with other joints. The changes related to the synovial membrane attain their maximum development in this joint, and may assume the form of hydrops with or without fibrinous bodies, or of overgrowth of the synovial fringes and the formation of pedunculated loose bodies. Fibrillation of the cartilage imparts a feeling of roughness when the joint is grasped during flexion and extension, and lipping of the margins of the trochlear surface of the femur may be felt when the joint is fully flexed. When a portion of the "lipping" is broken off it may give rise to the symptoms of loose body. In advanced cases with destruction of the cartilages, there may be lateral movement with grating of the articular surfaces.

In cases of hydrops, the joint may be tapped and iodoform injected. When the symptoms are due to the presence of hypertrophied fringes and loose bodies, these may be removed by operation. When the disease is of an aggravated type and is confined to one knee, the question of excising the joint should be considered.

*Bleeder's knee*, *Charcot's disease*, *hysterical knee*, and *loose bodies* in the joint have been described in the chapter on diseases of joints.

## The Ankle-Joint.

There is a common synovial cavity for the ankle and the inferior tibio-fibular joints. The lower ossifying junction of the fibula is included within the limits of this synovial cavity;

that of the tibia abuts on the surface immediately above the reflection of the synovial membrane (Fig. 207). The astragalus is related to three articulations—the ankle above, the astragalo-scaphoid joint in front, and the calcaneo-astragaloid joint below. The close proximity of the tendon sheaths to the ankle exposes them to the spread of infective disease from the joint; this is specially true of the sheaths of the peronei and of the tibialis posticus.

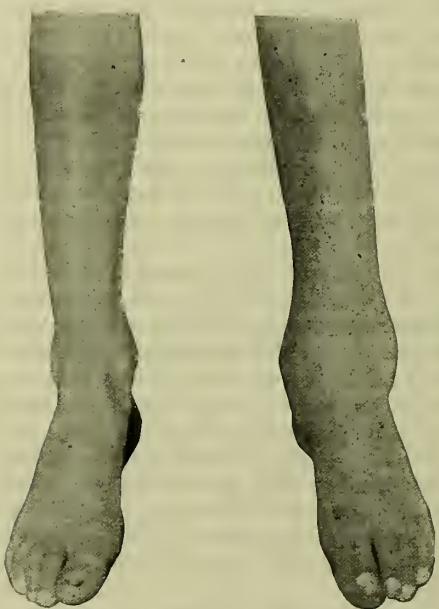


Fig. 273.—Tuberculous Disease of Synovial Membrane of Left Ankle, in a girl æt. 15.

**Tuberculous Disease.** — Tuberculous disease at the ankle is as frequently met with in adolescents and adults as it is in children. In the majority of cases it commences in the synovial membrane. Gross lesions in the bones are comparatively rare, and are more often met with in the head and neck of the astragalus than in the lower ends of the tibia and fibula.

Primary synovial disease usually exhibits the features of white swelling, anteriorly, projecting beneath the extensor tendons, and posteriorly, filling up the hollows on either side of the tendo Achillis. At a later stage the swelling is seen also below the malleoli (Fig. 273). The foot may retain its normal attitude, or the toes may be slightly pointed and adducted. The calf muscles are wasted, there is little complaint of pain, and the movements of the joint may be so little interfered with that the patient can walk without limping.

When the articular surfaces have become affected, there is the usual pain and sensitiveness, the normal movements are restricted or abolished, and the patient is unable to put the heel to the ground.

Primary disease in the bones may cause enlargement of one

or other malleolus, localised pain and tenderness, and a limp in walking, the first sign may be the formation of abscess or the rapid development of articular symptoms. In such cases skiagrams may afford valuable information.

A combination of synovial and osseous disease is usually met with in advanced cases, the infection tending to spread diffusely throughout the whole region. Abscess formation is an early and prominent feature of disease of the ankle, whether of osseous or synovial origin, and sinuses are liable to form around the joint. Outlying abscesses and sinuses are usually the result of infection of the tendon sheaths in the neighbourhood.

When tuberculous teno-synovitis occurs independently of disease of the ankle, the swelling is confined to one aspect of the joint. In sarcoma of the lower end of the tibia, the swelling lacks the uniform distribution of that met with in joint disease. In Brodie's abscess of the lower end of the tibia, the ankle joint may be swollen, but tenderness is elicited on percussing over the bone.

The *treatment* is conducted on the same lines as in other joints of the lower extremity. The foot is immobilised at a right angle to the leg by splints or plaster of Paris. If it is proposed to inject iodoform, the point of the needle is inserted below either malleolus, and is then pushed upwards alongside of the astragalus. Abscess is treated on the usual lines (p. 150). If localised disease in one of the bones is recognised before the joint is infected, it should be eradicated by operation. If articular symptoms are absent or have subsided, the patient is encouraged to go about; a Thomas' knee-splint is the best apparatus, as it takes all the weight off the limb, but, failing this, crutches should be worn and a patten fixed to the boot of the sound limb.

When the disease is diffuse and resists conservative treatment, operation must not be delayed. The choice lies between arthrectomy and excision. In excising the joint, the articular surfaces of the constituent bones are removed, and it may be necessary to take away the whole of the astragalus.

Amputation should be restricted to adults with rapidly progressing disease and diffuse suppuration, and to cases which have relapsed after excision. Whatever method of amputation is employed, it is essential that the infected tissues should be completely removed to avoid recrudescence in the stump.

The other diseases of the ankle include *pyogenic*, *gonorrhœal*, *rheumatic*, *gouty*, and *hysterical* affections, *arthritis deformans*, and *Charcot's disease*. The last-named is generally associated

with a rapid and painless disintegration of the bones of the ankle and tarsus, resulting in great deformity and loss of the arch of the foot—sometimes associated with perforating ulcer of the sole.

Tuberculous disease in the **tarsus** and **metatarsus** has been considered in the chapter on diseases of bone (p. 602).

# CHAPTER XXXI.

## THE DEFORMITIES OF THE EXTREMITIES.

Palsies of children : *Infantile spinal paralysis—Spastic paralysis*—Congenital dislocation of hip—Paralytic deformities—Contractures and ankyloses of hip—Coxa vara—Congenital dislocations of knee and patella—Genu recurvatum—Paralytic deformities—Contractures and ankyloses of knee—Genu valgum and genu varum—Congenital deformities of leg—Bow-leg—Club-foot : *Talipes equino varus—Pes equinus—Pes calcaneus—Pes calcaneo-valgus and varus—Pes cavus*—Flat-foot and pes valgus—Metatarsalgia—Hallux valgus and bunion—Hallux varus—Hallux rigidus and flexus—Hammer-toe—Hypertrophy of toes—Supernumerary toes—Webbed toes—Congenital absence of clavicle—Winged scapula—Congenital paralytic deformities of shoulder—Deformities of elbow—Club-hand—Deformities of wrist—Deformities of fingers—Dupuytren's contraction—Polydactylism.

In this chapter we shall study those abnormalities in the attitude and form of the limbs—whether congenital or acquired—which are capable of being benefited by mechanical or operative treatment. This subject constitutes an important branch of what is known as orthopædic surgery.

The important part played by the palsies of children in the production of deformities necessitates a short description of these affections.

**Infantile spinal paralysis** results from an affection of the spinal cord known as anterior poliomyelitis, which occurs during the first few years of life. After an illness of a few days, attended with fever, the child is found to have lost power in one of the lower extremities ; less frequently both legs are paralysed, or one or rarely both arms. For a time the paralysis remains stationary, but after a period varying from six weeks to three months, it tends to diminish both in extent and in degree, and in the majority of cases it ultimately persists only in certain groups of muscles. The limb affected is cold and the skin often bluish, and it readily ulcerates if exposed to pressure ; the reflexes are lost ; the paralysed muscles are wasted and for a time exhibit the reaction of degeneration. The limb lags behind its fellow in growth, and it tends to assume a deformed attitude, which at first can easily be

corrected but in course of time becomes permanent. The deformities resulting from anterior poliomyelitis are due to the shortening of unopposed, healthy, or less affected muscles—the shortening finally amounting to contracture—to the effects of gravity, and, in the lower extremities, to the superincumbent weight of the body.

*Surgical treatment* is directed towards the prevention of deformity, or to its correction when it has already taken place. As soon as the fever and other acute symptoms have subsided, the limb is massaged and protected from cold. If there are any voluntary movements preserved, the child is encouraged to practise them, and precautions are taken to prevent the limb assuming an abnormal attitude. By means of splints or other apparatus the limb is fixed in such an attitude as to stretch the shortened muscles and relax those which have become lengthened. By means of an operation the tendons of functionating muscles may be divided and attached to the tendons of muscles which are paralysed—a proceeding known as *transplantation of tendons*, originally devised by Nicoladoni. When all the muscles acting on a joint are paralysed, and the limb is thereby rendered useless for support or progression, the joint may be artificially ankylosed—a procedure introduced by Albert and known as *arthrodesis*. In extreme cases, where the limb is hopelessly paralysed and useless, amputation may prove the best treatment, by rendering it possible to have recourse to an artificial substitute.

**Cerebral Palsies of Childhood — Spastic Paralysis.** — These may be due to arrest of the development of the brain, to injuries of the head at birth, to meningeal hæmorrhage, or to other lesions of the brain with secondary degenerative changes in the spinal cord. The paralysis may affect one side of the body—hemiplegia; or both sides—diplegia; less commonly one extremity alone is involved—monoplegia. The mental functions may be unimpaired or they may be very imperfectly developed, the impairment in some cases amounting to idiocy. There may be generalised convulsions. The affected limbs exhibit muscular rigidity or spasm, which is exaggerated on movement but disappears under an anæsthetic; the reflexes are exaggerated, and sometimes there are perverted involuntary movements (*athetosis*). The growth of the limb is impaired, and contracture deformity may supervene. The amount of power in the limb is often astonishing, in marked contrast to what is usually observed in infantile spinal paralysis. The amount of natural improvement is by no means great, and normal function is almost never regained. In hemiplegic cases the upper limb is, as a rule, more severely affected than the lower. In diplegia, in which to start with both arms and both legs are affected, the arms may recover and the lower extremities remain the seat of spastic paralysis (Little's disease).

Treatment is mainly concerned with the prevention or correction of deformity. A muscle which is the seat of spasm should be put at rest by lengthening its tendon in order to relieve the constant pull on the weak, overstretched opponent, and to get rid of the tendency to spasm. The recognition of the particular tendons which should be lengthened or divided in any individual case requires most careful consideration. Operative interference is only to be recommended in cases in which the intellectual development is fair, in which there are no general convulsions or involuntary perverted movements of the nature of athetosis.

## DEFORMITIES OF THE LOWER EXTREMITIES.

### Congenital Dislocation of the Hip.

This is the commonest of all congenital dislocations. Its frequency varies in different countries, being greater on the



Fig. 274.—Radiogram of Congenital Dislocation of Hip in a girl æt. 4.

(Photograph by Dr. Dawson-Turner.)

continent of Europe than in Britain. It is more frequently unilateral than bilateral, and is about seven times more common in girls than in boys.

Of the many views which have been expressed regarding its etiology, that of Hoffa appears the most feasible. He believes that the dislocation takes place in the early months of intra-uterine life, and is probably associated with deficiency of the liquor

amnii. The lower extremities of the fœtus *in utero* being flexed and adducted, the elastic pressure of the wall of the uterus displaces the head of the femur past the acetabulum. The acetabulum, being unoccupied, does not develop properly, but remains flattened and shallow, so that when the child comes to put its weight on the limb, the head of the femur is pushed upwards and lies against the ilium. The greater frequency of the dislocation in girls is probably due to the fact that in the female fœtus the acetabulum faces the lateral aspect of the pelvis, while in the male it is directed more forwards.

*Pathological Anatomy.*—The anatomical changes in the parts concerned vary in children of different ages. At birth, the head of the femur lies just above the acetabulum, and it is often elongated or conical, sometimes its articular surface is uneven, and a little depressed in relation to the great trochanter. The acetabulum is narrow, elongated, and shallow, and is often partly filled up with fat and connective tissue.

In children who have reached the stage of walking, the head is pushed further and further upwards under the influence of the weight of the body, until it comes to lie just outside the anterior superior spine. The acetabulum becomes triangular with the apex above and behind. In contrast to what is observed in traumatic dislocations, a new socket is very rarely formed, because the head of the femur is separated from the ilium by the thickened capsule of the joint.

With increasing years the neck of the femur becomes atrophied, and forms with the shaft an angle which approaches a right angle. The capsular ligament becomes unusually thick and elongated, and may assume an hour-glass shape as a result of the play of the head of the femur. The ligamentum teres is frequently absent in bilateral cases, but when present, as it nearly always is in unilateral dislocation, it is elongated and strongly developed. The muscles undergo important alterations both in length and direction; those which pass more or less horizontally from the pelvis to the trochanter are elongated, while those which run longitudinally, including the adductors and hamstrings, are shortened.

*Clinical Features.*—The condition rarely attracts attention until the child begins to walk, and this may be delayed until the age of two or even three years.

*In unilateral dislocation* there is a decided limp and shortening of the limb on the affected side. The limp in walking is due not only to the head of the bone sliding upwards on the ilium, but also to the alteration in the direction of the

muscles, especially of the gluteus medius and minimus. These muscles which normally maintain the pelvis horizontal are no longer able to do so, and every time the child puts the dislocated limb to the ground and lifts the other one, the trunk suddenly lurches to the sound side. The shortening, which increases with age, and may finally amount to several inches, is partly compensated for while standing by resting the affected

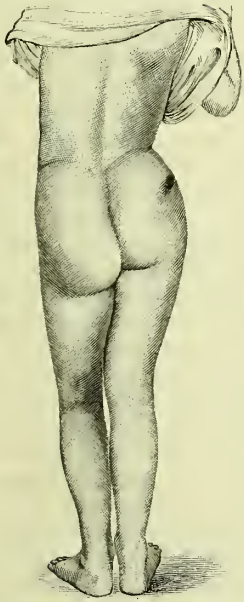


FIG. 275.—Congenital Dislocation of Right Hip in a girl æt. 9. The trochanter on the right side is indicated by a mark.



FIG. 276. — Congenital Dislocation of Right Hip in a girl æt. $2\frac{1}{2}$, showing lordosis of lumbar spine.

limb on the balls of the toes and by flexing the knee of the sound limb.

The muscles of the buttock and thigh are smaller, the trochanter is prominent and at a higher level, and the gluteal fold is shorter and deeper (Fig. 275). The trochanter is well above Nélaton's line. The head of the femur is absent from its normal situation, and may be felt just below or immediately to the outer side of the anterior superior spine. The pelvis is inclined forwards, and this is associated with flexion at the hip and well-

marked lordosis of the lumbar spine (Fig. 276). The spine is also curved laterally with the concavity to the affected side. The lordosis partially disappears when the child lies on its back, and the scoliosis disappears on equalising the length of the limbs by placing a flat object, such as a book, under the sole. The limb can be moved freely in all directions except abduction. In young children, if the pelvis is fixed, the head of the bone may be made to glide upwards and downwards on the ilium.

*In bilateral dislocation* there is a more pronounced alteration in the attitude and gait of the patient. The trunk appears well grown in contrast to the short lower limbs, the lordosis of the lumbar spine is very marked, and is associated with undue prominence of the belly and of the buttocks. The gait is waddling, like that of a duck, the trunk lurching from one side to the other with each step.

In all cases, the deformity and disability become more and more pronounced as the capsular and round ligaments become further stretched by the weight of the body. With increasing years, therefore, the shortening and limp become more marked, the patient suffers from fatigue and pain on using the limb, and so may be unable to undertake any occupation involving much standing or walking. The sooner the affection is recognised and treated the greater is the prospect of cure.

The *diagnosis*, except in infants who are very fat, is easy. In coxa vara (p. 725), the limb is shortened and the trochanter is displaced upwards, but the head of the femur may be felt to be in the acetabulum, and cannot be made to move up and down; the limb is rotated out, and abduction is even more restricted than in dislocation. In the flail joint of infantile paralysis, the resemblance to congenital dislocation may be very close; the muscles, however, are more wasted and are slack, and the normal attitude can be more easily restored by pulling on the limb. If a careful examination is made, there should be no difficulty in differentiating the condition from hip disease. Both for purposes of diagnosis and treatment the X-rays are of great value (Fig. 274).

*Treatment.*—The most rational and satisfactory treatment is to reduce the dislocation by manipulation, or, if this ideal result is not attainable, to displace the head of the bone into such a position that it will no longer glide upwards on the ilium. Paci, Schede, Mikulicz, Lorenz, and Hoffa have specially developed the treatment of congenital dislocation on these lines.

*Reduction by Manipulation.*—The child is anæsthetised;

extension is applied to the leg through the medium of a hank of worsted fixed above the malleoli, and counter-extension to the trunk by means of a perineal band; the traction is gradually increased until the trochanter is brought down to the level of Nélaton's line. When this is accomplished the limb spontaneously assumes the abducted position and the prominence of the trochanter disappears, and in its place there is a marked depression. During this procedure the adductor tendons stand out like cords, and should be divided subcutaneously or stretched by firmly pressing on them with the thumbs.

The head of the femur having been brought down to the level of the acetabulum, is made to turn towards the socket by flexing the thigh and rotating it slightly inwards, and if while the limb is still in this position the thigh is abducted to the maximum degree —about 90°—the head of the femur glides over the posterior border of the acetabulum and enters the socket, often with an audible click and an appreciable vibration of the limb. After reduction, the abducted limb should be rotated outwards until the head of the femur bulges the soft parts in the fold of the groin.



Fig. 277.—Limb fixed in Plaster of Paris, after reduction of congenital dislocation by manipulation.

The limb must be maintained in the abducted position, by a plaster case, which includes the lower part of the trunk and the affected limb down to the knee (Fig. 277). The first bandage is changed after ten or twelve weeks, and is then renewed at shorter intervals, the angle of abduction being diminished at each renewal until the limbs are nearly parallel. At the end of six months the bandage is given up, and massage and exercises are employed.

In bilateral cases, both dislocations should be reduced at one sitting if possible, and a plaster case applied with both thighs abducted and flexed to a right angle. In the event of failure to reduce the dislocation on the first attempt, the limb should be

fixed in plaster in the attitude of abduction and eversion for fourteen days, and then another attempt made. Reduction is successful in the great majority of children under six years of age, and the younger the child the greater is the prospect of success.

Although the above method of treatment does not always enable us to restore the condition to the normal, the functional results obtained are extremely satisfactory.

*Reduction by open operation* may be had recourse to in cases in which after several attempts reduction has failed, or in which redislocation has occurred. The operation consists in exposing the joint by a lateral or anterior incision, drawing aside the muscles, dividing the capsular ligament, displacing the head of the bone, enlarging and deepening the acetabulum by means of the gouge, and replacing the head in the socket. Subcutaneous tenotomy of the adductor and hamstring tendons may be necessary. The best results are obtained when this operation is performed between the third and eighth years.

In young adults who are seriously incapacitated by the deformity, an attempt may be made to improve the condition of affairs; this may be accomplished by an operation which secures a firm fibrous ankylosis at the hip in the abducted position of the limb.

**Paralytic Deformities of the Hip.** — These result from infantile or from spastic paralysis, and are often associated with deformities of the knee and ankle. In infantile paralysis the hip-joint may become flail-like and useless—a condition which may be relieved by wearing a supporting apparatus. In spastic paralysis the tendency is towards contracture, usually in the attitude of flexion with adduction and inversion, and this may be remedied by massage, weight extension, and division of the shortened structures—the adductors, tensor fasciæ femoris, sartorius, and ilio-tibial band; the patient is then placed in a double abduction frame, precautions being taken to prevent the formation of pressure sores. The contracture may finally result in dislocation on to the dorsum ilii, and this may even occur in patients who are confined to bed (Fig. 278). Reduction of the dislocation is rarely possible without having recourse to an open operation.

**Contractures and Ankyloses of the Hip.**—Other forms of contracture are met with as a result of cicatricial contraction, or from shortening of the fasciæ, muscles, and ligaments in conditions in which the hip is maintained in the flexed position for long periods—for example, in psoas abscess, chronic rheumatism, or hysteria. The majority, however, result from

tuberculous disease of the hip-joint, and have already been considered.

**Coxa Vara—Incurvation of the Neck of the Femur.**—The term coxa vara is applied to a deformed attitude of the hip

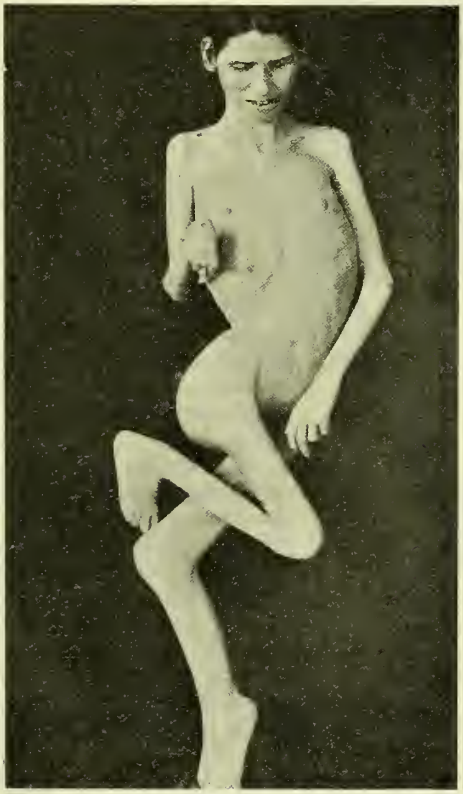


Fig. 278.—Contracture Deformities of Upper and Lower Limbs resulting from spastic cerebral palsy in infancy.
(Photograph taken after death.)

which results from an alteration in the axis of the neck of the femur, whereby the head is depressed either to or below the level of the great trochanter—incurvation of neck of femur (Fig. 279).

*Pathological Anatomy.*—The changes in the upper end of the femur vary in different cases. There may be a simple adduction bend of the neck of the bone, so that its angle is diminished from

about 125° to about 60°, or this may be combined with a forward curving of the neck. In the majority of cases the neck presents a curve with the convexity upwards and forwards, while its lower border is greatly shortened, so that the head of the bone may come into contact with the lesser trochanter, and the shaft is adducted and rotated outwards. Less commonly the bend involves also the upper third of the shaft. The cause of the bending is the weight of the body acting on bone which has been softened by any disease, such as rickets, osteomalacia, or osteomyelitis, and unless arrested by treatment the condition tends to get worse.



FIG. 279.—Coxa Vara, showing adduction curvature of neck of femur.

**Adolescent Coxa Vara.**—This, the most common clinical type, is met with chiefly in boys between the ages of twelve and eighteen. It is usually unilateral. The deformity and resulting disability may be the first indications of the condition, or there may be pain and stiffness at the hip before there is any deformity. The patient usually complains of being easily tired, of difficulty in kneeling and sitting, and of an increasing limp in walking.

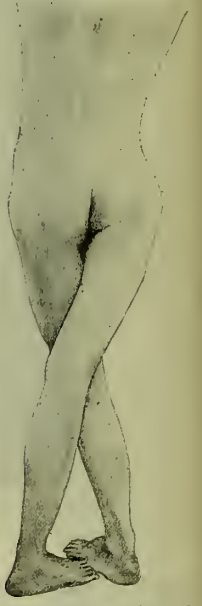


FIG. 280.—Bilateral Coxa Vara, showing scissors-leg deformity.

On examination, the limb is found to be shortened as much as two inches, and the great trochanter displaced upwards. The trochanter is usually displaced backwards as well as upwards, and is unnaturally prominent. The muscles of the buttock

and thigh are a little smaller and softer than on the normal side. One of the characteristic features is the attitude of the limb. The limb is adducted, and its normal range of abduction is considerably restricted. There is also, as a rule, some degree of external rotation, so that the toes are turned outwards and the patient is incapable of completely rotating the limb inwards. Flexion is also restricted. The deformity is partly compensated for by upward tilting of the pelvis and a certain degree of lateral curvature of the spine.

When the condition is *bilateral*, the attitude and gait are highly characteristic, as the adducted and everted legs tend to cross each other at the knee. The attitude and gait may be of the scissors-leg type (Fig. 280), and in extreme cases the patient may be unable to walk at all, or can only do so with the aid of crutches.

*Diagnosis.*—Coxa vara may be confused with hip disease and with congenital dislocation of the hip. When pain in the hip is an early symptom, and especially when it is also referred to the knee, the condition closely simulates hip-joint disease. The movements, especially those of rotation, are abolished in hip disease, while in coxa vara they are only restricted in the direction of abduction. In certain cases of tuberculous disease of the upper end of the femur, the bone may be softened, and bend so that the limb assumes the attitude of coxa vara, and it is very difficult to diagnose this from the bending due to rickets. The diagnosis from congenital dislocation of the hip can usually be made by the history, the examination of the joint and of its movements, and by the use of the Röntgen rays.

*Treatment.*—In the early stages of the disease, to relieve the pain and to prevent deformity, the patient must either give up standing and walking, or must wear a Thomas' knee-splint to take the weight off the limb. Rest in bed, with extension of the limb, is often necessary. The general health should be improved, and the muscles in the region of the hip massaged and exercised. After the pains and stiffness have disappeared cycling may be beneficial. When deformity is a prominent feature and seriously interferes with locomotion, improvement can be effected only by operation, which consists in performing osteotomy either through or below the great trochanter, the bone being divided obliquely downwards and inwards. The limb is then put up in the abducted position, the adductor muscles being divided if necessary to allow of this. The after treatment includes the use of massage and gymnastic exercises.

**Other Forms of Coxa Vara.**—In comparison with other

deformities of the skeleton due to the *rickets of childhood*, coxa vara is very rare. It is most often associated with pronounced eversion of both lower extremities (Fig. 281), without the capacity for abduction being necessarily restricted, and with but little impairment of function. If the child receives the appropriate treatment for rickets, and is put up in a double long splint with the limbs inverted and abducted, the deformity is usually recovered from.

In *arthritis deformans* of the hip-joint, it is not uncommon to have considerable depression of the head of the bone and diminution in the angle of its neck, with consequent restriction of abduction. Sometimes the upper end of the shaft is curved as shown in Figs. 267, 279.

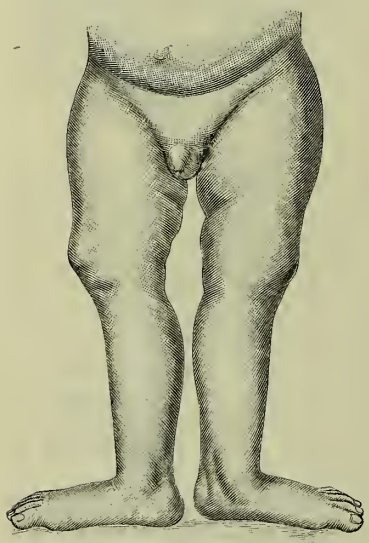


Fig. 281.—Eversion of Lower Limbs in Rickety Child, the subject of Coxa Vara.

Injuries of the upper end of the femur may result in coxa vara—*traumatic coxa vara* (Royal Whitman). When sustained in early childhood, greenstick fracture of the neck of the femur and separation of its upper epiphysis may result in softening of the bone, so that it bends under the weight of the body. The deformity, which is the same as that of the adolescent form, may, however, not show itself until puberty. The treatment is carried out on the lines already indicated.

### Deformities in the Region of the Knee.

**Congenital Dislocation** at the knee-joint results from abnormal attitude of the fœtus *in utero* and is extremely rare; it is usually incomplete, and its direction varies. The displacement may be permanent, or may only occur from accidental movements of the limb. In some cases it can be produced at will by the patient or the surgeon.

**Congenital absence of the patella** may exist along with

other congenital abnormalities in the knee-joint, very rarely does it occur by itself. The functions of the knee may be absolutely unimpaired. The tubercle of the tibia is prominent and the extensor tendon very thick. In flexion the tendon rises on to the outer condyle of the femur.

**Congenital Dislocation of the Patella Outwards.**—This may be persistent or intermittent. In the *persistent form* the patella rests on the trochlear surface of the external condyle, and when the knee is flexed, may pass further outwards and become completely dislocated, lying against the outer aspect of the condyle (Fig. 282).

In *the intermittent form* the patella lies in its normal place, but is liable to be displaced outwards when the joint is flexed; the displacement usually occurs suddenly and unexpectedly in walking, and the patient falls to the ground, suffering intense pain. The knee-cap is readily replaced on extending the joint, but the patient is usually disabled for a day or two. It is met with chiefly in girls, and there is usually a history that the child was late in walking and learned with difficulty. On examination, the patella is found to have an abnormal range of movement outwards, although it cannot be completely dislocated without causing severe pain. The condition is frequently bilateral, and is attributed to imperfect development of the external condyle of the femur. It is also met with in association with aggravated forms of knock-knee.



FIG. 282.—Outward Dislocation of Patellæ in a girl æt. 14.

To prevent the outward displacement of the patella, the ligamentum patellæ may be detached from the tubercle of the tibia and fixed with sutures to a point internal to the tubercle, or the gracilis may be divided at its insertion, brought through a hole in the vastus internus and fixed to the inner border of the patella, the inner part of the capsule, and the muscular substance of the vastus internus (Lanz).

**Genu Recurvatum.**—In this deformity the knee is hyperextended, the thigh and leg forming an angle which is open forwards (Fig. 283).

There are several varieties. In the *congenital forms*, which are apparently due to a faulty attitude of the lower extremities *in utero*, the patella may be imperfectly developed or absent, and in some cases the tibia is dislocated forwards. The knee is convex backwards, and attempts to flex the joint cause pain. When the deformity is bilateral, the patellæ are usually imperfectly developed and the joints are flail-like and permit of lateral movements. The treatment consists in flexing the joint to a right angle under an anæsthetic, and maintaining this attitude by means of plaster of Paris or splints until the growth of parts prevents any tendency to relapse.

*Acquired Forms.*—The most common acquired form is the



Fig. 283.—Genu Recurvatum.
(Mr. Pitts' Case.)

result of infantile paralysis, and is described in the next section.

The deformity may also be met with in rickets as the result of a backward bend of the tibia immediately below its upper epiphysis—sometimes combined with an exaggerated forward curve of the femur. If there is no prospect of spontaneous rectification, the upper end of the tibia should be divided with the osteotome, and the limb straightened.

It may result also from fracture or from separation of one of the epiphyses in the region of the knee, or from cicatricial contraction of the quadriceps. As a result of bone and joint disease, it is met with chiefly in neuro-arthropathies when the knee has become disorganised and flail-like.

**Deformities of the Knee associated with Infantile and Spastic Paralysis.**—When all the muscles acting on the knee are paralysed, the joint may be so *flail-like* that the patient is unable to stand without the aid of a crutch, or when the weight of the body is put on the limb it assumes the attitude of genu

recurvatum. The treatment for the flail-joint is the application of a rigid apparatus or the operation of arthrodesis.

When the quadriceps is alone paralysed, the patient is obliged to maintain the joint in the position of extreme extension because he finds that the least degree of flexion results in the limb giving way under him. In course of time the posterior ligament becomes stretched, and the joint becomes hyper-extended, acquiring the attitude of *genu recurvatum*. The treatment consists in wearing an apparatus which ensures rigidity of the joint, or in transplanting the sartorius, tensor fasciæ femoris and portions of the hamstrings into the aponeurosis of the quadriceps extensor, so as to compensate for the loss of power in this muscle. In extreme cases it may be better to perform arthrodesis.

When the quadriceps is overcome by a spastic contraction of the hamstrings, and the knee is rigidly fixed in the flexed position, it is usually necessary to carry out division or even resection of the hamstrings through a longitudinal incision on either side of the popliteal space; the limb is then put up in a splint or frame which will maintain full extension at the knee-joint for a period of three months. In some cases it may be necessary to transplant portions of the hamstrings into the quadriceps. If there is a combination of flexion and genu valgum as shown in Fig. 284, the knee-joint should be excised and ankylosed in the straight position.



Fig. 284.—Spastic Paralysis of both Lower Limbs in a boy æt. 15, showing contracture deformities. There is flexion, adduction and inversion at the hip, flexion and genu valgum at the knee and talipes equino-varus.

**Contracture and Ankylosis at the Knee.**—In addition to the different paralytic forms above described, contracture may result from hysteria, from ulceration and suppuration in the popliteal space, and from disease—osteomyelitis—in one of the

adjacent bones. The greater number of contractures and ankyloses are the result of disease in the joint, and have already been described.

### Genu Valgum and Genu Varum.

In the normal limb, a line drawn from the centre of the head of the femur to a point midway between the malleoli passes through the centre of the knee-joint. If the line passes outside

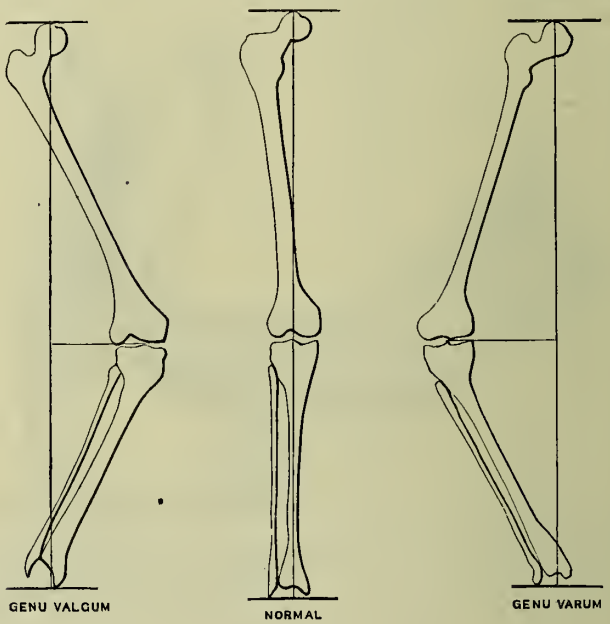



Fig. 285.

the centre of the knee-joint, the condition is one of genu valgum; if inside, it is one of genu varum (Fig. 285).

**Genu Valgum—Knock-knee.**—In this deformity the leg joins the thigh at an angle which is open outwards. When the affection is bilateral the projecting knees tend to knock against each other in walking, and the term X-legs may be applied to it.

*Etiology.*—The observations of Macewen and of Mikulicz, and information afforded by the Röntgen rays, have shown that the primary cause of the deformity is an inequality of growth at the ossifying junctions of the femur and tibia. This inequality

of growth is due to the presence of rickets, and its direction is determined by a faulty attitude of the limbs in standing and walking. The legs being abducted, the weight of the body falls unequally on the outer and inner parts of the ossifying junctions, and inequality of growth results.

*Pathological Anatomy.*—Examination of the femur usually shows that the lower third of the diaphysis of the femur is lengthened on its inner side and shortened on its outer side, and that the epiphysis, itself unaltered, is fitted on to the diaphysis obliquely, so that the internal condyle appears to be increased in length and to occupy a level distinctly below that of the external condyle (Fig. 286). In some cases the tibia shows corresponding alterations. On section of the bones, the epiphysial cartilage and the zone of ossification are found to be thicker, and more irregular than normal —changes which are characteristic of rickets.

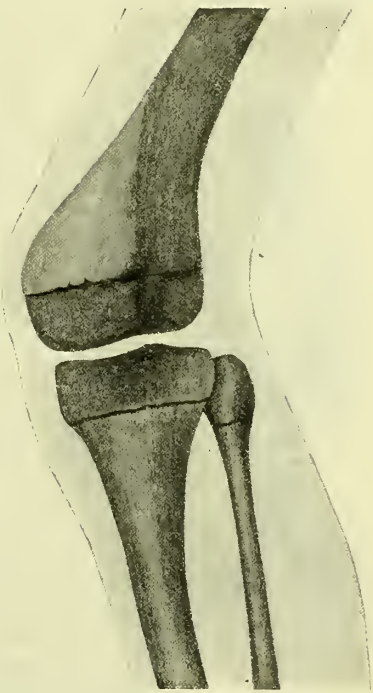


Fig. 286.—Drawing of radiogram of case of Genu Valgum.

The neck of the femur is shortened and its angle diminished. The bones of the leg are sometimes bent inwards in their lower thirds, and this compensates partly for the valgus deformity at the knee. The articular cartilage of the external condyle and the external semilunar cartilage are usually thickened. In pronounced cases the quadriceps tendon and the patella are displaced outwards. The changes in the soft parts are secondary to those in the bones. It has been shown by Symington that the biceps tendon and ilio-tibial band are shortened and more prominent as a result of the approximation of their attachments, and that they are also displaced outwards. The sartorius and

gracilis are displaced backwards, so that they descend behind instead of on the inner side of the knee. The popliteal artery lies on the back of the external condyle instead of in the hollow between the condyles, and the internal popliteal nerve is displaced even further outwards. The capsular and other ligaments are usually slack, so that the joint is wobbly and easily hyper-extended. There is often a little effusion into the joint.

*Clinical Features.*—In the infantile form (Fig. 287) the knock-knee is very commonly associated with signs of rickets in other parts of the skeleton, and especially with bending of the tibia and femur, and in extreme cases the child may be unable to walk.



Fig. 287.—Knock-knee in Child æt. 5, the subject of Rickets.

The deformity is about as frequently bilateral as unilateral. There may be knock-knee on the one side and bow-knee on the other. The apparent disappearance of the valgus attitude on flexion of the knee has been the subject of much discussion; it has been attributed to simultaneous outward rotation of the limb at the hip and to the immunity of the posterior portions of the condyles from the obliquity of the articular surface of the femur. It was originally pointed out by Albert that if a strip of paper be cut at an angle so as to represent a genu valgum, the mere folding of the paper causes the angle to disappear. It is usually possible to hyper-extend the knee, and, in the extended position to rotate the leg out to a greater extent than is normal. In unilateral knock-knee, the affected limb is a little shorter than its fellow, but the patient compensates for this by depressing the pelvis on the affected side.

*Prognosis.*—While there is some prospect of spontaneous recovery in children under six years, the usual tendency is for the deformity to increase until the skeleton reaches maturity at the age of eighteen or twenty.

*Treatment of Infantile Knock-knee.*—The general treatment is directed towards curing the rickets. So long as this disease is active the child should not be allowed to stand or walk. The limbs should be strengthened by douching and massage twice daily, finishing on each occasion with manipulations which

are directed to undoing the deformity. Of the numerous forms of apparatus devised for knock-knee, the simplest consists of a light padded splint applied on the outer side of each limb, extending from the iliac crest to three inches beyond the foot. The splint is fixed above and below by bandages, and the projecting knee is drawn towards it by a few turns of elastic webbing. In the mildest cases they are only worn when the child is indoors. In pronounced cases these splints are only removed for purposes of massage and bathing. A modified form of Thomas' knee-splint is efficacious, but requires careful supervision. A simpler plan of treatment, specially applicable to hospital out-patients, is to straighten the limbs as far as possible under chloroform and envelop them in plaster of Paris. The procedure is repeated at intervals of three weeks until the legs are quite straight. Whatever plan is adopted, it must be persevered with for at least six months, until the bones have become rigid.

If the child is approaching the age of five or six before it comes under treatment, or if the deformity does not yield to treatment by splints, it is better to straighten the limb by osteotomy, taking precautions, however, to prevent relapse of the deformity until the softness of the bones has entirely disappeared.

In *adolescent knock-knee* the conditions are different from those obtaining in the child. In the majority of cases the patient seeks advice because of the deformity alone, but in addition he may complain of pain after exertion, especially at the inner side of the epiphysial junctions, of being easily tired, and of incapacity for any laborious occupation, or even for one involving much standing. In many cases the bones are large and coarse and badly formed, and there is frequently an obtuse or pointed spinous process projecting downwards from the inner tuberosity of the tibia.

In bilateral adolescent knock-knee, the patient abducts the thigh at each step and rotates the limb outwards at the hip, so as to disguise the deformity, and to allow the projecting knees to pass each other more easily. He usually supinates or inverts the foot, and turns the toes inwards, with the object of bringing the whole length of the outer border of the sole into contact with the ground. Flat-foot is exceptional. The boots usually show evidence of the toes being turned in, and they are more worn along the outer than along the inner border of the sole and heel.

Splints and apparatus — especially such as allow of the

patient walking—are of little or no value. If the deformity is at all marked, there should be no hesitation in recommending osteotomy. If the femur is chiefly concerned, it should be divided above the condyles after the method of Macewen, or a wedge is removed from the inner side of the femur as recommended by Professor Chiene. If the tibia is mainly responsible, it should be divided below the epiphysis, along with the fibula. In case of failure to remedy the deformity completely by one of these procedures, it should be supplemented or followed by the other. It is rarely necessary to divide the tendon of the biceps or the ilio-tibial band. The patient gains in height by the operation, but a considerable time usually elapses before his capacity for walking attains the normal standard.



Fig. 288.—Bow-knee in Rickety Child.

In severe cases it may be found that when the deformity is corrected by Macewen's operation, the patella shows a marked tendency to be dislocated outwards as soon as the knee is flexed beyond a certain degree. Inasmuch as this liability to dislocation of the patella is a very disabling factor, it should be guarded against by putting up the limb after operation in the attitude of slight genu varum.

**Other forms of genu valgum** than those described as resulting from rickets are relatively rare. There is a congenital form arising from faulty position of the limbs *in utero*; a traumatic form following fracture or epiphysial separation in the region of the knee; and a paralytic form, usually combined with flexion, in cases of spastic paralysis. Finally, genu valgum may be a result of osteomyelitis of the lower end of the femur, or of disease in the knee-joint, such as tuberculosis, arthritis deformans, or Charcot's disease.

**Genu Varum—Bow-knee.**—In this deformity, which is in nearly every respect the converse of genu valgum, the leg joins the thigh at an angle which is open inwards. It is almost invariably bilateral and of rachitic origin (Fig. 288). It is frequently associated with bow-legs. The tibia takes a greater

share in its production than the femur. Although an ungainly deformity, it is much less frequently the source of complaint than knock-knee, because it does not interfere with locomotion —as a matter of fact the subjects of it, although short in stature, are unusually sturdy on their legs.

Treatment is carried out on the same lines as in genu valgum. If an operation is required to straighten the limbs, the tibia should be divided below the epiphysis in the first instance. In adolescents it may also be necessary to divide the fibula. If by this the deformity is not corrected, the femur should be divided above the condyles. It may even be necessary to divide the shafts of the tibia and fibula, especially where there is bow-leg as well. This should be performed, however, at a subsequent operation.



Fig. 289.—Bow-leg in Rickety Child.

**Rickety Deformities of the Bones of the Leg—Bow-legs.**—These deformities are very common in children under five, and they are nearly always bilateral and symmetrical. They may occur before the child is able to walk, the bones bending in the attitude in which they are habitually placed —over the nurse's knee, for example, or as they are crossed underneath the child in sitting. In children who are able to walk, the deformity is due to the weight of the body acting on the softened bones. In either case, the bending may be increased by the traction of muscles, and sometimes by the occurrence of green-stick fracture. The most common deformity is a uniform curvature of the bones outwards and somewhat forwards, or a more acute bend in the lower thirds of their shafts (Fig. 289). In some cases the chief curvature is forwards. The ungainliness in walking may be added to by flat-foot. The deformity of the legs may be associated with knock-knee or bow-knee. Backward curving of the upper end of the tibia has been already described as one of the causes of genu recurvatum.

The most extreme and persistent deformities are met with in rickety dwarfs (Fig. 233).

The chances of natural straightening of the curvature are very considerable in children under six years, and especially in those who are actively growing.

*Treatment.*—Under the age of six, and particularly in children who are actively growing, the bones will probably straighten if the patient is treated for rickets and kept off his feet. Well-padded external splints should be applied as recommended for knock-knee, and these should be taken off at intervals for massage and douching, and manipulations tending to undo the curvature. To save time the bones may be forcibly straightened under chloroform. Above the age of six, when the bones have become hard, they must be divided at the seat of greatest curvature. In the tibia an oblique or vertical osteotomy may suffice, but it is more satisfactory to remove a segment of the bone by means of the wire saw. The fibula can usually be forcibly straightened, but may require to be divided through a separate incision. In aggravated cases it may also be necessary to divide the tendo Achillis.

The deformities of the bones of the leg in inherited syphilis, ostitis deformans, and osteomalacia have already been described.

**Congenital Deficiencies of the Bones of the Leg.**—The *tibia* may be absent completely or in part. In either case the leg is short and stunted, the knee is flexed, the foot occupies the position of extreme equino-varus, and the limb is useless. The exact nature of the defect is demonstrated by the Röntgen rays. When the upper end of the tibia is absent, the fibula articulates with the external condyle of the femur. The operative treatment aims at correcting the flexion at the knee, and the equino-varus of the foot, and at substituting the fibula for the absent tibia. The deficiency of the upper end may be compensated for by implanting the head of the fibula between the condyles of the femur, and that at the lower end by splitting the fibula so as to form a socket for the astragalus. If an operation is inapplicable or fails, the deformed leg may be amputated to allow of the use of an artificial limb.

The *fibula* may be absent completely or in part. The clinical appearances depend upon the condition of the tibia. When the tibia is normal, the most notable feature is the absence of the outer ankle bone, and the extreme valgus attitude of the foot. More commonly the tibia makes a sharp forward bend just below its middle, and the overlying skin presents a dimple or scar-like depression. This has usually been regarded as an

evidence of intra-uterine fracture of the tibia, but the observations of Hoffa show that both the bend of the bone and the depression on the skin are due to pressure exercised upon the leg from without by an amniotic band or adhesion. The leg fails to grow, the deformity becomes more pronounced, and the toes become pointed. If the tibia is markedly bent, it may be straightened by osteotomy. If the ankle is unstable as a result of the absence of the external malleolus, it may be artificially ankylosed, or the lower end of the tibia may be split vertically so as to make a socket for the astragalus. In either case, the foot is placed in the equinus attitude to compensate for the shortening of the leg. Deficiency of the tibia is frequently associated with imperfect development of the great toe; deficiency of the fibula with absence of the outer toes and their metatarsal bones.

*Volkmann's Supra-malleolar Deformity.*—This term is applied to a congenital deficiency in the development of the bones of the leg, and specially of the fibula, as a result of which the articular surface is oblique and the foot deviates to one or other side. The foot usually occupies a valgus position, the sole looking outwards, and only its inner border being in contact with the ground. It is treated by supra-malleolar osteotomy.

## Deformities of the Foot.

Various deformities are met with in the region of the ankle and tarsus. The term "talipes" is commonly used to include all these, but here will be restricted to that form in which the heel is more or less elevated, and the foot supinated so that it rests on its outer border—*talipes equino-varus or club-foot.* In *pes equinus* the foot is in the position of plantar-flexion, and the patient walks on the toes. In *pes calcaneus* the foot is dorsi-flexed so that the tip of the heel comes in contact with the ground. This deformity may be combined with eversion of the foot, *pes calcaneo-valgus*, or with inversion, *pes calcaneo-varus.* When the instep is unduly arched the terms *pes cavus*, *pes arcuatus* or *hollow claw-foot* are employed; while loss of the arch constitutes *flat-foot* or *pes valgus.*

## Club-foot.

**Talipes Equino-varus.**—This deformity may be congenital or acquired.

**Congenital talipes equino-varus** is a very common malforma-

tion (Fig. 290). It may be met with in several members of one family, and is sometimes associated with other congenital deformities such as hare-lip or spina bifida. It is twice as common in boys as in girls, and is more frequently bilateral than unilateral. Its etiology is still obscure, and various hypotheses have been put forward to account for it, but no one is convincing. It may be pointed out, however, that the fœtal foot is very easily moulded into abnormal attitudes by external pressure, such as might be exercised by the wall of the uterus when the liquor amnii is deficient. In a limited number of cases there are indications of such pressure over the bony prominences of the foot, in the shape of circumscribed scar-like areas in which the skin is atrophied.

*Pathological Anatomy.*—In well-marked cases the long axis of the foot presents a concavity towards the inner side, the maximum point of the curve being opposite the mid-tarsal joint. When the patient attempts to stand, only the outer border of the foot touches the ground and the weight is borne on the base of the fifth metatarsal, the cuboid, and the greater process of the os calcis.

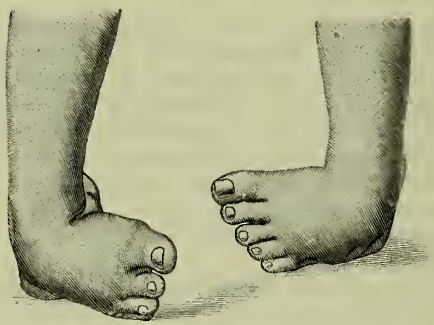


Fig. 290.—Congenital Talipes Equino-varus in an Infant.

The individual tarsal bones, especially the astragalus and os calcis, are altered in shape as well as in their relations to one another and to the tibio-fibular socket. The scaphoid and cuboid are rotated inwards around the anterior ends of the astragalus and os calcis respectively, and the tubercle of the scaphoid comes to lie very close to the internal malleolus. The lower third of the tibia is twisted inwards on its long axis.

The changes in the soft parts follow the general law that tissues which are relaxed become shortened, while those which are put on the stretch are lengthened. All the tissues on the inner, concave, side of the foot are shortened, the structures most affected being the internal lateral and the posterior ligaments of the ankle, and the inferior calcaneo-scaphoid ligament. There is also shortening of the muscles inserted into the tendo Achillis,

and to a less extent of the tibiales anticus and posticus. The extensor tendons on the dorsum are displaced inwards.

*Clinical Features.—In children who have not walked*, the degree of deformity varies in different cases. Sometimes it is very slight. In pronounced cases, the foot is turned inwards and in that position forms a right angle with the leg; the sole looks backwards and the inner border upwards. The foot appears shortened because it is curved on itself, the heel is narrower and more vertical than normal, the inner malleolus is obscured by the approximation of the scaphoid, and the external malleolus is unduly prominent.

In extreme cases, the supinated foot may form an acute angle with the leg, and there is frequently a deep transverse depression across the sole, the result of contraction of the plantar fascia—a feature which is distinctive of the congenital form of club-foot.

*In children who have walked*, the deformity becomes aggravated. The dorsum of the foot is markedly uneven, partly because of the prominence of the individual tarsal bones, and especially of the head of the astragalus and greater process of the os calcis, and partly because of a depression over the neck of the astragalus. Instead of resting on its outer border, the foot may finally rest on the dorsum, the sole looking upwards and backwards. While the skin over the heel remains comparatively thin and delicate, that covering the outer border and dorsum of the foot becomes the seat of callosities, beneath which adventitious bursæ are formed. These bursæ are liable to become inflamed, and are then a source of great suffering, and if they suppurate they may cause persistent sinuses. The muscles of the leg and foot, although not paralysed, undergo atrophy from disuse. In walking, the patient lifts one foot over the other in an ungainly and laborious manner, as if walking on stilts.

*In adults*, these features are still further aggravated, and there are permanent changes in the bones (Fig. 291).

*Prognosis.*—The slighter degrees of club-foot may be completely corrected; the severe forms may be improved so as to give the patient a useful limb.

*Treatment.*—This should be commenced as soon as the viability of the infant is beyond question, as the younger the patient the more easily and completely is the deformity rectified. Manipulations directed towards the correction of the deformity should be carried out twice or thrice daily, and the limbs should also be massaged and douched. In the intervals between the

manipulations, the foot should be maintained in the corrected attitude by some simple form of splint. At the end of two or three months, assistance may be derived from the use of a simple lateral poroplastic or aluminium splint with a foot-piece, or some other form of apparatus which aims at correcting the deformity. If this regime is systematically persevered with from within a few days after birth, by the time the child is able to put its foot to the ground the deformity will be so far corrected that some form of apparatus can be worn.



Fig. 291.—Congenital Talipes Equino-varus, in man æt. 24.

If the equinus element resists correction, the tendo Achillis should be lengthened.

If the sole can be brought into contact with the ground, the weight of the body also acts in the direction of correcting the deformity.

The turning in of the toes is best overcome by strapping the feet at night to a wooden board with the whole lower limb rotated outwards so that the toes of each foot point directly outwards. On account of the tendency towards relapse, the manipulations and massage must be persevered with for at least a year.

*Tenotomy and Forcible Correction under Chloroform.*—In more severe cases we have to deal not only with the contracted

soft parts, but with changes in the bones resulting from their having grown in adaptation to the deformed attitude.

The soft parts most requiring division are the tendo Achillis, the internal and posterior ligaments of the ankle, the plantar fascia, the calcaneo-scaphoid ligaments, and the tibialis posticus tendon. The varus deformity may then be corrected by laying the foot on its outer side on a padded triangular wooden block, and pressing forcibly on the anterior and posterior ends of the foot so as to undo the curve on its inner side and allow of abduction of the foot; this is usually attended with cracking as the shortened ligaments give way. The equinus element is next corrected by forcibly dorsi-flexing the foot until the deformity is over-corrected. If it is preferred to correct the deformity in stages instead of at one sitting, the equinus element is left to the last. In older children, the strength of the hands is usually insufficient and mechanical wrenches may be employed, such as those devised by Thomas, Bradford, or Lorenz.

*Phelps' operation* (A. M. Phelps, 1878), which consists in open division of the soft parts on the inner aspect of the foot, is indicated in moderately severe cases of club-foot in which the bones are still to a large extent cartilaginous. Having rendered the foot bloodless, and having divided the tendo Achillis and posterior ligament of the ankle subcutaneously, a transverse incision is made across the inner, concave, aspect of the foot opposite the astragalo-scaphoid joint, dividing everything down to the bone, the foot meanwhile being forcibly abducted, everted, and dorsi-flexed. The gaping wound is then closed by a flap of the redundant skin dissected up from the dorsum, and the foot is secured in the over-corrected attitude.

*Resection of a wedge from the tarsus* (Davies Colley, 1876) is reserved for the most severe cases in which the shape and rigidity of the bones absolutely prevent correction of the deformity by any other means. A curved incision is made on the outer side over the most prominent part of the convexity of the tarsus, the soft parts are separated and drawn aside, and by means of an osteotome a wedge of bone, sufficiently large to admit of over-correction of the deformity, is removed. The base of the wedge is on the outer aspect and the bone removed includes parts of the os calcis, cuboid, astragalus, and scaphoid. The tendo Achillis and tibialis posticus are divided with a tenotomy knife. The wound is closed and the foot maintained in position by bandages and splints.

*Removal of the astragalus* is an alternative operation to resection of the tarsus, and yields at least equally good results.

In the case of children before the tarsal bones have become completely ossified, Ogston has suggested that, instead of removing a wedge from the tarsus, the osseous nucleus of each individual bone should be gouged out, leaving the cartilaginous shell. In this way the intertarsal joints are not interfered with, the cartilaginous tarsus can be moulded so that when ossification is completed the bones differ but little from the normal.

After any of these operative procedures, manipulations, massage, exercises, electrical stimulation of the muscles and the wearing of some apparatus must be persevered with for at least twelve months. Failures are due to not sufficiently over-correcting the deformity in the first instance, and to neglect of after-treatment.

Finally, *amputation* may be called for when other methods have failed, and the patient is unable to put the foot to the ground because of suppurating bursæ and ulceration of the skin.

**Acquired Talipes Equino-varus.**—In the great majority of cases this condition results from infantile paralysis, especially affecting the peronei and extensors of the toes, and is unilateral. The patient is unable to dorsi-flex and abduct the foot, which hangs with the toes pointed and the sole turned in (Fig. 292). At first the joints are quite flaccid, and the attitude can easily be corrected by manipulation. In course of time, however, the opposing muscles—those inserted into the tendo Achillis, the tibialis posticus, and the long flexors of the toes — become shortened, and there is secondary contraction of the plantar fascia and of the ligaments on the inner side of the foot, and the deformity is thus rendered permanent. The bones also are altered in their shape and mutual relations, the astragalus being rotated forwards so that a large portion of its trochlear surface protrudes from the tibio-fibular socket. The skin of the foot is cold and livid, and readily suffers from pressure sores. The whole limb is ill-developed, and may be shorter than its fellow, and the paralysed muscles are wasted and exhibit for a time the reaction of degeneration.

A similar deformity may result from section of the external popliteal nerve, from the peroneal form of progressive muscular atrophy, and from peripheral neuritis.

The *treatment* of talipes equino-varus due to infantile paralysis varies in different cases. If the deformity is easily corrected, and the paralysis is confined to the extensor and peronei muscles, satisfactory results are obtained by reenforcing the paralysed muscles by those which are still active. For example, the tendo Achillis may be split longitudinally, one-half of it cut across and attached to the distal end of the divided

peroneus longus and brevis. Tubby and Jones recommend the plan of splitting the tendo Achillis throughout its entire length, and the gastrocnemius as well, so making a new muscle, the lower end of which is attached to the distal end of the peronei tendons.

If the paralysis is more widely distributed, and the ankle and tarsal joints are flail-like, it is better to ankylose the calcaneo-astragaloid and ankle-joints. It may be necessary to divide the plantar fascia and other structures which have undergone secondary shortening.

The after-treatment is of great importance, and consists in massage, douching, exercises, and electric stimulation of the muscles. As using the limb hastens the restoration of function, the patient should be got on to his feet as soon as possible.

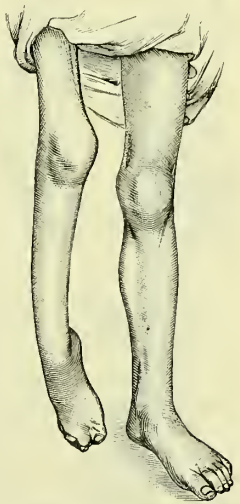


Fig. 292.—Infantile Paralysis of Right Lower Extremity in a girl æt. 15. The limb is short and wasted, and the foot is in the position of equino-varus.

Talipes equino-varus resulting from *spastic paralysis* is comparatively rare. Certain groups of muscles—the plantar flexors and invertors—are the seat of a persistent spasm which gradually merges into contracture, with the result that the foot is distorted and assumes the equino-varus attitude (Fig. 284). The heel is markedly drawn up, the anterior part of the foot is adducted and inverted at the mid-tarsal joint. The muscles are tense and rigid, and the tendon reflexes exaggerated. The condition is frequently bilateral, and is often associated with other deformities of the lower limb and with a characteristic spastic gait. Considerable improvement may be brought about by division or lengthening of the tendons of the shortened muscles. In severe cases it may be necessary to resect a portion of the tarsus or to remove the foot by amputation.

The occurrence of pure **varus without equinus** is so exceptional as not to call for separate description.

**Pes Equinus.**—This deformity, in which the foot is in the position of plantar flexion with the heel drawn up and the toes pointed, is nearly always acquired as a result either of infantile

or of spastic paralysis. In typical cases the patient walks on the balls of the toes (Fig. 293). It is seldom met with as a congenital condition. Occasionally it is due to nerve lesions such as peripheral neuritis, or to injuries and diseases in the region of the ankle where the foot has been allowed to remain for long periods in the attitude of plantar-flexion. In a limited number of cases, the equinus attitude is assumed to compensate for shortening of the limb.



Fig. 293. — Bilateral Pes Equinus in a boy æt. 7, the result of spastic paralysis.

In *infantile paralysis* it is most often unilateral (Fig. 294). If the muscles in front of the leg alone are paralysed, the heel is drawn up by the unopposed contraction of the calf muscles. If all the muscles of the leg are paralysed, the foot drops into the equinus attitude by its own weight.

In *spastic paralysis*, the deformity is frequently bilateral (Fig. 293) and is usually accompanied by excessive arching of the foot (pes cavus) from plantar-flexion at the mid-tarsal joint, and by hyper-extension of the first phalanges and plantar-flexion of the second and third phalanges of the toes —"clawing of the toes."

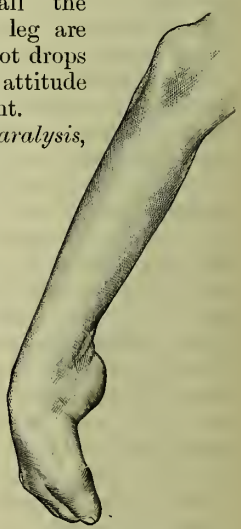


Fig. 294.—Extreme Form of Pes Equinus in a girl æt. 8, the result of infantile paralysis.

*Clinical Features.*—In the mildest cases the patient is able to bring the foot to a right angle, and the condition is easily overlooked. In average cases the heel is raised off the ground, and the foot rests on the balls of the toes. In extreme cases, and especially when the extensors are completely paralysed, the toes may be flexed towards the sole, and the foot rests on the dorsum. The patient suffers from painful corns and callosities, and from inflammation of bursæ which form over the points of pressure. When unilateral, the patient compensates for

the lengthening of the limb by flexing the knee and throwing the limb outwards in walking. In severe cases, especially when both limbs are affected, the patient may be entirely dependent on crutches.

The astragalus projects on the dorsum, the anterior part of its trochlear surface escapes from the tibio-fibular socket, and the os calcis is drawn up so that it comes into contact with the bones of the leg (Fig. 295).

Shortening of the soft parts affects chiefly the muscles inserted into the tendo Achillis, the posterior ligament, and posterior parts of the lateral ligaments of the ankle. The fasciæ, ligaments and muscles of the sole of the foot are also shortened. The flexors of the toes, the tibialis posticus, and the peroneus longus are shortened to a less degree.



Fig. 295.—Skeleton of Foot from case of Pes Equinus due to infantile paralysis.

*Treatment.*—Of all the deformities of the foot, pes equinus is that most easily rectified. The treatment is conducted on the same lines as in talipes equino-varus. In recent cases a great deal may be done by regular manipulations, massage, exercises and electricity, and by the wearing of some corrective splint or apparatus between times.

In well-marked cases it is necessary to divide the shortened structures, and especially the tendo Achillis. It may be lengthened as follows: the tenotomy knife is introduced into the centre of the tendon close to its insertion, and is made to cut half-way across it: the knife is again introduced one inch higher up, and is made to cut across the opposite half of the tendon. An open operation is to be preferred. On forcible extension the tendon readily elongates to the desired extent. The excessive arching of the foot (pes cavus) and the clawing of the toes usually disappear when the equinus is corrected, but it may be necessary to divide the extensor tendons, especially that of the great toe, and also the plantar fascia.

In aggravated cases of long standing, the bones must be attacked, as, for example, by excising the astragalus. Arthrodesis of the ankle and calcaneo-astragaloid joints may be indicated when these joints are flail-like. Amputation is reserved for cases which are otherwise hopeless. When the deformity is

compensatory to shortening of the limb, it is usually said to be a mistake to correct the equinus. Experience shows, however, that in young patients the growth of the limb is stimulated by walking on the limb after the deformity has been corrected.

**Pes Calcaneus.**—In this deformity the foot is dorsi-flexed at the ankle-joint. It is sometimes combined with eversion of the foot—*pes calcaneo-valgus*, or with inversion—*pes calcaneo-varus.*

**Pure pes calcaneus** may be congenital or acquired. In the *congenital form* the deformity is frequently bilateral. There is dorsi-flexion at the ankle-joint, and if an attempt is made to flex the foot towards the sole, the extensor tendons stand out prominently. In marked cases the long axis of the os calcis is vertical, the tendo Achillis lies in close contact with the tibia, and the hollows on either side of the tendon are absent. The peronei are displaced from their grooves, and may lie in front of the external malleolus.

Treatment is conducted on the same lines as in other congenital deformities of the foot. Corrective manipulations are commenced within a few days after birth, and a mouldable splint is worn between times. When the child begins to walk there is a natural tendency towards recovery. In severe cases it may be necessary to lengthen the contracted tendons—the extensor digitorum, the extensor hallucis, and, it may be also, the peroneus tertius and tibialis anticus.

In the *acquired form*, the appearances are very different because the anterior part of the foot is usually flexed towards the sole, thus disguising to a certain extent the dorsi-flexion at the ankle. This form is nearly always due to infantile paralysis in which the muscles of the calf are completely paralysed. It may also be due to division of the tendo Achillis. The anterior part of the foot is flexed towards the sole by the contraction of the plantar fascia and short muscles of the sole, the balls of the toes are approximated to the heel, and a deep transverse groove is formed in the sole opposite the mid-tarsal joint. The deformity presents a combination of the hollow foot—pes cavus—with pes calcaneus, and resembles that of a Chinese lady's foot. The patient rests on the heel and on the balls of the great and little toes, the sole of the foot being so deeply hollowed that even the outer border does not touch the ground.

The treatment varies with the conditions present. In paralysis of the calf muscles alone, the tendo Achillis may be reinforced by transplanting into it the peronei or flexor longus

digitorum. If the calf muscles are not completely paralysed and the tendo Achillis is merely stretched, this tendon may be shortened by splitting it longitudinally and making the ends overlap, or its insertion may be displaced downwards. When the ankle is flail-like it may be necessary to perform arthrodesis. The cavus element in the deformity is also to be treated.



Fig. 296.—Pes Calcaneo-valgus with excessive arching of foot.
(From a cast in Mr. Annandale's collection.)

**Pes Calcaneo-valgus.**—This deformity, which consists in a combination of dorsi-flexion at the ankle and eversion of the foot, is fully as common as pure calcaneus (Fig. 296). The heel is depressed, the sole looks outwards, the arch of the foot is usually absent and its inner border is convex. Although it may be congenital, it is usually acquired as a result of infantile paralysis. The calf muscles are paralysed while the peronei retain their power and along with the tibialis anticus and the extensors of the toes become secondarily contracted. Treatment is conducted on the same lines as in pes calcaneus.

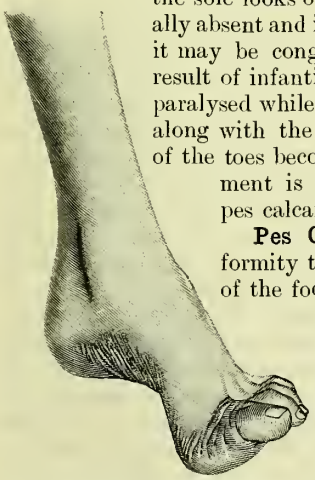


Fig. 297.—Pes Cavus in association with Pes Equinus, the result of infantile paralysis.

**Pes Calcaneo-varus.**—In this rare deformity the heel is depressed and the sole of the foot looks inwards.

**Pes Cavus.**—In this deformity, which is known also as hollow claw-foot, pes arcuatus, or pes excavatus, the longitudinal arch of the foot is exaggerated as a result of the approximation of the balls of the toes to the heel (Fig. 297). It is most frequently met with as an addition to pes equinus or pes calcaneus of paralytic origin, and has already been described. There is a mild form which

is congenital, and which is quite independent of paralysis. It is attributed to paralysis of the extensor brevis digitorum or of the interossei, but the evidence in support of this explanation is by no means convincing. It occurs in certain rare diseases of the spinal cord, such as Friedreich's ataxia.

The name hollow claw-foot appropriately indicates the clinical appearances. The arch is exaggerated and the instep abnormally high; there is hyper-extension of the toes at the metatarso-phalangeal joints, and plantar-flexion at the inter-phalangeal joints; the plantar fascia and muscles are shortened. The footprint shows that neither border of the foot touches the ground. The patient may complain of pain in the instep, of painful corns over the heads of the metatarsal bones, and of difficulty in getting properly fitting boots.

*Treatment* should first be directed towards the equinus or calcaneus element of the deformity, for if these are corrected the cavus condition tends to disappear. The contracted structures in the sole may require to be divided, either subcutaneously or by the open method, as a preliminary to forcible correction.

### Flat-foot—Pes Planus and Pes Valgus.

Flat-foot or splay-foot is that deformity in which there is loss of the arch, and the foot tends to be pronated and abducted. The term *pes planus* is applicable when there is merely loss of the arch; *pes valgus* when the foot is pronated so that the sole tends to look outwards. Of all deformities of the foot, flat-foot is the one for which advice is most frequently sought. It is usually bilateral, and is about twice as common in men as in women. Various types of flat-foot are met with; they are known as static, congenital, traumatic, paralytic, rachitic, rheumatic, arthritic, gonorrhœal, and tabetic.

**Static or Adolescent Flat-foot.**—This, by far the most common and most important variety of flat-foot (Fig. 298), most frequently develops between the ages of fourteen and twenty. It is called static because the essential factor in its production is a disproportion between the weight of the body and the supporting power of the arch of the foot, when the patient is in the erect posture.

It is met with chiefly in rapidly growing persons with feeble muscles and long narrow feet, who, after leaving school, begin some occupation which entails much standing and walking —such as that of a factory hand, message boy, or domestic servant.

In order to continue standing without effort for long periods, the patient adopts an attitude which makes little demand on the muscles, and throws nearly all the strain of the body weight on the ligaments and bones of the feet. This, which has been called by Annandale "the attitude of rest," consists in standing with the limbs apart, the knees slightly flexed, the legs slightly rotated outwards at the knee, and the feet pronated with the toes pointing outwards. The most important local factors predisposing to flat-foot are weakness of those muscles of the leg and foot which normally lend support to the ankle, and to the tarsal arches, specially the tibialis posticus; weakness of the ligaments of the foot; and softness of the tarsal bones. When these conditions are present and the patient adopts a faulty method of standing and walking, the undue strain to which the tendons and ligaments are exposed result in their being stretched; the bones are altered in shape and position, and flat-foot results. The head of the astragalus is displaced inwards and is pushed in between the os calcis and scaphoid, tending to separate them from one another, stretching the inferior calcaneo-scaphoid ligament and causing the anterior part of the foot to be abducted. The plantar ligaments—specially the inferior calcaneo-scaphoid—at first become stretched and lengthened, and in course of time become thicker and stronger.

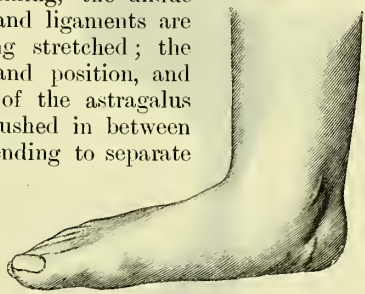


FIG. 298.—Adolescent Flat-foot.

*Clinical Features.*—The patient usually complains of being easily tired, and of pain in the feet after walking or standing. There is usually more pain when the deformity is commencing than when it is fully developed. Before there is any loss of the arch, the pain is liable to be wrongly ascribed to rheumatism or neuralgia, or to disease of the bones or joints. The most common seat of pain is at the inner border of the foot behind the tubercle of the scaphoid, and this is due to stretching of the inferior calcaneo-scaphoid ligament. Pain is also complained of in the middle of the dorsum across the instep, from stretching of the interosseous ligaments. Later, there is pain over the greater process of the os calcis in front of the external malleolus, from these bones coming into contact. There may be nocturnal cramp in the legs and feet. In exceptional cases pain is entirely absent.

On examination, the faulty attitude of the feet in standing and walking is usually evident. The foot appears longer and broader than normal, and tends to spread out with the toes extended until the entire sole is in contact with the ground. In more advanced cases, the inner border of the foot is not only in contact with the ground, but may be actually convex. Below and in front of the prominent internal malleolus, the head of the astragalus forms a rounded eminence, and a little further forwards and lower still is the projection of the



FIG. 299.—Imprint of Normal and of Flat Foot.

tubercle of the scaphoid. The eversion of the foot as a whole is best seen from behind. If the central axis of the leg is prolonged downwards, it approaches the inner border of the heel instead of passing through its centre. When the eversion is more pronounced, the sole looks outwards and the tendons of the peronei stand out in relief. The anterior part of the foot is displaced outwards. Flat-foot is frequently associated with hallux rigidus or hallux valgus.

The muscles of the leg are soft, flabby, and poorly developed. When the patient is seated and asked to move the foot in different directions, there is a characteristic stiffness, ungainliness, and restriction in the range of movement. The feet are

usually cold and damp, and sweat excessively. The gait is slouching, and there is a want of spring and elasticity. The boots after being worn show a bulging of the instep towards the sole, greater wearing away of the sole along the inner border, and, when there is hallux rigidus, an absence of the transverse crease on the dorsum opposite the balls of the toes. Footprints may be obtained by wetting the soles of the feet and asking the patient to stand. The print of a normal foot shows only the heel, the outer border of the foot, and the balls and tips of the toes. In flat-foot the inner border appears in the print to a greater or less extent (Fig. 299). The prints should be taken on smoked paper if a record is wanted to estimate the progress of treatment.

*Treatment.*—This is directed towards restoring and maintaining the arch of the foot. As the measures adopted necessarily vary with the extent to which the deformity has progressed, it is convenient for purposes of treatment to recognise the following four degrees. A first degree in which the arch reappears when the weight is taken off the foot or the patient rises on the balls of the toes; a second, in which the normal attitude can be restored by the manipulations of the surgeon; a third, in which this is only possible in narcosis; a fourth, in which the bones are so displaced and altered in shape that correction is impossible without an open operation.

*Cases of the First Degree.*—If there is marked pain and tenderness the patient must lie up. The general health is improved by a nourishing diet and by cod-liver oil and tonics. The legs and feet are douched and gently massaged thrice daily. When pain and tenderness have disappeared the patient is instructed how to walk and exercise the feet. In walking the inner edges of the feet should be parallel with one another, the heel should touch the ground first and then the balls of the toes. He should neither stand nor walk long enough to cause fatigue, and in standing he should alter the attitude of the feet from time to time, and occasionally rise on the balls of the toes. The following exercises, devised by Ellis of Gloucester, should be practised: (1) Rising on the balls of the toes, the toes being directed straight forwards; (2) rising on the balls of the toes, with the points of the great toes touching each other, and the heels directed out, so that the inner borders of the feet meet in front at a right angle; (3) in the same attitude, having risen on to the balls of the toes, the knees are flexed and then extended before the heels descend again; (4) while seated in a chair one leg

crossed over the other, circumduction movements of the foot are carried out; (5) while standing, the inner border of the foot is raised off the ground several times, then the patient walks to and fro on the outer border of the foot, and in the same attitude lifts one foot over the other. These exercises should be carried out slowly and deliberately, with the feet bare, and they should be carefully supervised until the patient thoroughly understands what is aimed at. The movements should be performed a definite number of times at regular intervals, but should not be pushed so as to cause pain or fatigue. The patient should be fitted with well-made lacing boots. In time, the limbs are further strengthened by sea-bathing, cycling, skipping, and other exercises.

In *cases of the second degree*, the patient should be provided with special boots or with a metal plate inside the boot. The "flat-foot boot" is a strong, well-made lacing boot, with the heel and sole thickened on the inner side so that the foot is forced to rest on its outer border (James Miller, 1846). A metal plate inside the boot, known as Whitman's Spring, is to be preferred to rubber pads. A plaster cast is taken of the sole while the foot is held in its proper position, and on this a metal plate, preferably of aluminium bronze, is modelled. This is covered with leather and inserted into the boot. The treatment described for cases of the first degree is carried out in addition.

In *cases of the third degree*, the deformity is corrected under an anæsthetic. The foot is forcibly moved in all directions so as to stretch the shortened ligaments and to break down adhesions, it is then rotated into an extreme varus position, and fixed in plaster of Paris or to a Dupuytren's splint. When the reaction consequent upon this procedure has settled down, the question of shortening or of reinforcing the tendons mainly concerned in the support of the arch of the foot may be considered.

In *cases of the fourth degree*, in which the displacement and deformity of the bones constitute an insuperable bar to correction, some form of operative treatment is indicated. Among the numerous proccdures recommended we would restrict the choice to one or other of the following:—

*Resection of a Wedge from the Astragalo-Scaphoid Joint* (Ogston).—A longitudinal incision is made over the projecting head of the astragalus and the tuberosity of the scaphoid. These bones are cleared of soft parts, and the opposing articular surfaces are removed with the chisel in such a fashion that the astragalus is left convex and the scaphoid concave. The opposed articular surfaces of the scaphoid and internal cunei-

form may also be removed. The foot is then forcibly inverted, and the cut bony surfaces are brought into contact and fixed by pegs.

*Supra-malleolar osteotomy of the tibia and fibula* (Trendelenburg) is equally efficient in allowing the foot to be inverted. After either operation the limb is encased in plaster, or put up in a Dupuytren splint.

**Spasmodic Flat-foot**—There are cases of flat-foot in which pain and muscular spasm, chiefly of the peronei, are the predominant features. If the spasm is not allayed by rest in bed and hot fomentations, it is to be eliminated by a general anæsthetic. The foot then becomes quite loose and is easily inverted, and in this position it is encased in plaster of Paris.

**Paralytic Flat-foot** (Fig. 300).—In typical cases this results from infantile paralysis affecting the tibialis anticus or posticus, or both. When other groups of muscles are affected at the same time, compound deformities, such as pes calcaneo-valgus, are more likely to result.

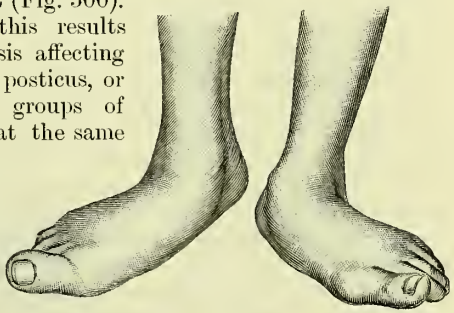


Fig. 300.—Bilateral Pes Valgus in a girl æt. 15, the result of infantile paralysis.

In uncomplicated paralytic valgus the inner border of the foot is depressed and convex towards the sole, and although the foot can readily be restored to the normal position by manipulation, it at once resumes the valgus attitude when left to itself. The leg is wasted, the foot is cold and livid, and the ankle tends to be flail-like. The treatment consists in the transplantation of tendons—substituting the flexor longus digitorum, peroneus longus, or one-half of the tendo Achillis for the paralysed tibial muscles—or in bringing about an ankylosis of the joints above and below the astragalus.

**Traumatic flat-foot** is that form which results directly from injury. It is most often due to a fall from a height on to the soles of the feet; the ligaments supporting the arch are ruptured, and the bones are displaced either at the time of the injury, or later when the patient begins to walk. The arch can only be restored by a wedge-resection of the tarsus similar to that described above. Loss of the arch may follow as a result of walking on the everted foot after injuries about the ankle,

especially a badly united Pott's fracture, the foot may be displaced outwards and pronated, the sole looking outwards (Fig. 209). It is treated by supra-malleolar osteotomy of the tibia and fibula.

**Other Forms of Flat-foot.**—Flat-foot is sometimes met with in rickety children, in association with knock-knee or curvature of the bones of the legs, and is treated on the same lines as other rickety deformities. Flat-foot may follow upon an attack of acute rheumatism or upon diseases in the region of the ankle and tarsus, such as those resulting from gonorrhœa, arthritis deformans, tuberculosis, and Charcot's disease. There is a congenital form of flat-foot in which the sole is convex and the dorsum concave, the result of the persistence of an abnormal attitude of the fœtus *in utero*. Lastly, there is a racial variety of flat-foot, chiefly met with in negroes and in Jews, which is inherited and developmental, and which, although unsightly, is rarely a cause of disability.

**Metatarsalgia.**—This affection, which was first described by Morton of Philadelphia, is a neuralgia of the plantar aspect of the foot in the region of the heads of the third and fourth metatarsal bones. It is most often met with in adults between thirty and forty, and is commoner in women than in men. The patient complains of a dull aching or of an intense boring pain in the anterior part of the foot. The pain is usually relieved by taking off the boot and by rest. It may be excited by squeezing the heads of the metatarsals together or by grasping the fourth metatarso-phalangeal joint between the finger and thumb. In advanced cases the pain may be so severe as completely to cripple the patient, so that he is obliged to use a crutch. On examination, the sole may be found to be broadened across the balls of the toes, and there may be corns over the heads of the third and fourth metatarsals. Skiagrams may show a downward displacement of the head of one or other of these bones. Prints of the foot may show an increased area of contact in the region of the balls of the toes. The affection is sometimes traced to an injury, but is more often of insidious development, and is then ascribed to sinking of the transverse arch of the foot, the result of wearing badly fitting boots. The intense pain is believed to be due to stretching of, or pressure upon, the interdigital nerves or the communicating branch between the internal and external plantar nerves. The affection is often combined with ordinary flat-foot.

*Treatment.*—Great improvement usually results from treating the co-existing flat-foot. Pain is relieved by rest, massage, and douching. A tight bandage or strip of plaster applied round the

instep before putting on the stocking may relieve pain. Boots should be made from a plaster cast of the foot, high and narrow at the instep so as to compress the bases of the metatarsals, with thick soles and the inner edge of the heel slightly raised. When the head of one of the metatarsals is displaced, it should be removed through a dorsal incision running parallel with the tendon of the long extensor.



Fig. 301.—Double Hallux Valgus, with rotation of the great toe on its long axis.

**Hallux Valgus and Bunion.**—*Hallux valgus* is that deformity in which the great toe deviates towards the middle line of the foot and comes to lie on the top of, or beneath, the second toe (Fig. 301). The head of the first metatarsal projects on the inner border of the foot (Fig. 302*a*), and, as a result of the pressure of the boot, an adventitious bursa is formed, which, when thickened by chronic inflammation, constitutes a prominent swelling or *bunion*. It is a very common affection in civilised, and especially in urban communities, and it reaches its acme of development in adult women. It may occur on one or on both sides, and it may be associated with flat-foot.

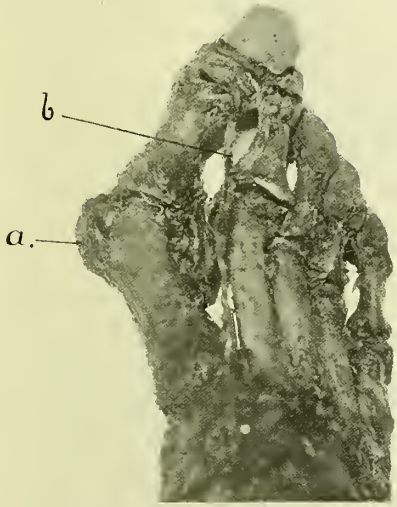



Fig. 302.—Hallux Valgus.
*a*, Projecting head of first metatarsal.
*b*, Tendon of extensor of great toe, displaced outwards.

The deformity is of very slow development, and is usually attributed to the wearing of improperly made boots. The boot which favours the occurrence of hallux valgus is one which is too short and which has pointed toes, with the apex in the middle line of the foot instead of being in line with the great toe. The pressure of the boot displaces the

great toe into the valgus position, especially if a high heel is worn, as the toes are then driven forwards into the apex of the boot. An important factor in the production of hallux valgus is a faulty method of putting the foot to the ground in walking, which consists in bearing unduly on the inner side of the ball of the great toe, and in pointing the foot outwards. Once the great toe is abducted by the pressure of the boot, the deformity is increased by this method of walking.

Examination of the joint in pronounced cases shows that the base of the first phalanx is displaced on to the outer aspect of the head of the first metatarsal, and the exposed head of the latter frequently shows changes like those met with in arthritis deformans, and is often the seat of periosteal overgrowth, sometimes amounting to an exostosis (Fig. 302*a*). Arthritis deformans is rarely the cause of hallux valgus, but may follow upon it. The distal end of the first metatarsal is displaced inwards, broadening the tread of the foot, and in severe cases its shaft is rotated on its long axis, so that its dorsal surface looks inwards; the great toe is then similarly rotated (Fig. 301). The flexor and extensor tendons and the sesamoid bones are displaced outwards. The ligaments and other soft parts on the inner side are elongated, while those on the outer side are contracted.

In some cases, the patient's chief complaint is of the deformity of the foot and the consequent disfigurement of the boot; in others, the complaint is of the pain and disability resulting from the sensitiveness of the joint and of the enlarged bursa over the head of the first metatarsal. The inflamed bursa, which sometimes communicates with the joint, may even suppurate and discharge for long periods, and the infection may spread to the joint.

The *treatment* varies with the severity of the deformity. In mild cases, a great deal can be done by wearing properly made boots, by wearing stockings with a separate compartment for the great toe, or, a pad of cotton wool between the great and second toes, by frequent manipulations and exercises of the toes and feet, and by instructing the patient how to put the foot to the ground in walking. In more pronounced cases, the pain and tenderness must first be got rid of by rest and soothing applications. At night, the attitude of the toe may be corrected by a moulded splint fixed to the inner aspect of the foot by strips of plaster; the toe is then bandaged to the distal end of the splint. If there is flat-foot, this must receive appropriate treatment.

In aggravated cases of long standing, the deformity can only

be corrected by operation. A curved incision, with its convexity towards the sole, is made on the inner aspect; the flap of skin is reflected upwards, the bursa excised, the bone bared of soft parts, and its articular portion removed. If the toe still tends to be abducted, the contracted outer portion of the capsule of the joint is divided, the displaced sesamoids are removed, and the tendon of the long extensor may be detached from its insertion into the terminal phalanx and stitched to the fibrous tissues on the inner side of the proximal phalanx. To prevent stiffness, movements must be persistently carried out.

**Hallux Varus or Pigeon-toe.**—In this deformity which is extremely rare, the great toe deviates from the middle line of the



FIG. 303.—Hallux Rigidus and Flexus in a boy æt. 17. There is a suppurating corn over the head of the first metatarsal bone.

foot; it is met with chiefly in children in conjunction with other deformities. It interferes with the wearing of boots. Treatment consists in straightening the toe and retaining it in position by a splint or plaster of Paris. The internal lateral ligament and the tendon of the abductor hallucis may require to be divided subcutaneously.

**Hallux Rigidus and Hallux Flexus** (Fig. 303).—These terms indicate two stages of an affection of the metatarso-phalangeal joint of the great toe, first described by Davies Colley. In the earlier stage—*hallux rigidus*—the toe is stiff and incapable of being dorsi-flexed, although plantar-flexion is, as a rule, but little restricted. When the joint, in addition to being stiff, is painful, sensitive and swollen, the term *hallux dolorosus* is applied.

As the disease progresses, the toe is drawn towards the sole and becomes permanently flexed—*hallux flexus*—and any attempt at dorsi-flexion is attended with pain.

The condition is met with chiefly in adolescent males, is very commonly associated with flat-foot, and is then usually bilateral. The patient's gait, in addition to having the characteristic features associated with flat-foot, is peculiarly wooden and inelastic, as instead of rising on the balls of the toes with each step, he puts down and lifts the sole as if it were a rigid plate. The pain is increased by walking. The boot tends to become worn away at the point of the toes and at the posterior edge of the heel, and the usual crease across the dorsum is absent.

On dissection it is found, especially in hallux flexus, that the inferior portions of the lateral ligaments are contracted, and that the cartilage of that part of the head of the metatarsal which is exposed on the dorsum is converted into fibrous tissue. Bony ankylosis has not been observed.



FIG. 304.—Hammer-toe.

*Treatment.*—In early cases, great benefit results from measures directed towards the cure of the accompanying flat-foot. If the joint of the big toe is painful and sensitive, absolute rest should be enforced until these symptoms have disappeared. The patient must wear a properly shaped boot with a pliable sole, and be instructed how to manipulate and exercise the toe. Later, when the toe is already rigid or flexed towards the sole, the above treatment is not feasible. It is best to correct the deformity either by wrenching the toe into the dorsi-flexed position, under anæsthesia, and fixing it with a plaster of Paris bandage; or when this is impossible, by excising the articular end of the metatarsal bone. When these measures are impracticable, the patient's sufferings may be relieved by inserting in the boot a rigid metal plate which will prevent any attempt at dorsi-flexion in walking.

**Hammer-toe.**—This is a flexion-contracture which usually involves the second, but sometimes also other toes. It is sometimes congenital and inherited, but usually develops about puberty, and is then, as a rule, bilateral.

The first phalanx is dorsi-flexed, the second is plantar-flexed, while the third varies in its attitude, sometimes being in line

with the second (Fig. 304), sometimes even more plantar-flexed, and sometimes dorsi-flexed. When the second toe alone is

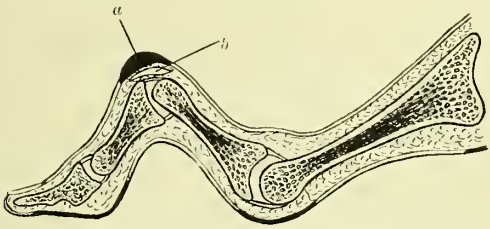



Fig. 305.—Section of Hammer-toe.
*a*, Corn. *b*, Bursa over first inter-phalangeal joint.

affected, as is commonly the case, it is partially buried by those on either side of it, only the knuckle of the first inter-phalangeal joint projecting above the level of the other toes (Fig. 304). The skin over the head of the first phalanx being pressed upon by the boot usually presents a corn, under which a bursa forms (Fig. 305). Both the corn and the bursa are subject to attacks of inflammation, which cause considerable suffering and disability in walking. The soft parts at the distal extremity of the toe are flattened out by contact with the sole of the boot—hence the supposed resemblance to the head of a hammer.

On dissection, it is found that the contracture depends on shortening of the plantar portions of the lateral ligaments of the first inter-phalangeal joint, and of the glenoid ligament upon which the head of the first phalanx rests.



Fig. 306.—Congenital Hypertrophy of Left Lower Extremity in a boy æt. 5. The second and third toes are fused with one another.

Hammer-toe is usually ascribed to the use of ill-fitting boots, especially those which are median-pointed and are too short for the feet, but in some persons there appears to be an inherited predisposition to this deformity.

*Treatment.*—While corrective manipulations, strapping, and the use of splints may be of service in slight cases, it is usually necessary to perform an operation in order to extend the toe permanently. Before operating, any septic condition, such as a suppurating corn or bursa, must be corrected. The lateral and glenoid ligaments are divided subcutaneously; and if the toe can then be straightened, the foot is secured to a metal splint moulded to the sole and provided with longitudinal slots opposite the intervals on either side of the toe affected. The toe is drawn down to the splint by passing a loop of cotton or elastic bandage round the toe and through the slots. In many cases the contraction of all the tissues on the plantar aspect, including the skin, prevents the toe being straightened even after division of the ligaments, and it is then necessary to remove the head and neck of the first phalanx through a lateral incision. We have found this to be more satisfactory than the removal of the affected toe at the metatarso-phalangeal joint, as after amputation the adjacent toes fall together and there is a tendency to the development of hallux valgus. If amputation is performed a pad of cotton wool should be worn in the vacant space.

**Hypertrophy of the Toes.**—One or more of the toes may be the seat of hypertrophy or local giantism. This is usually present at birth or appears in early childhood, and may form part of an overgrowth involving the entire lower extremity (Fig. 306). The overgrowth may involve all the tissues equally, or the subcutaneous fat may be specially affected. The inner toes are those most commonly hypertrophied. In addition to being enlarged, the toe may be displaced from its normal axis. The hypertrophy may affect two or more toes which are fused together or webbed (Fig. 306). The treatment consists in amputating as much of the toe as will allow of the patient wearing an ordinary boot.

**Supernumerary Toes** (*Polydactylism*).—These vary from mere appendages of skin to fully developed toes. If they interfere with the wearing of boots they may be removed.

**Webbing of the Toes** (*Syndactylism*).—This may affect two or more toes, which may be united merely by a web of skin, or are so completely fused that the individual digits are only indicated by the nails. The degree of fusion is readily shown by means of skiagrams. Unless associated with congenital hypertrophy no treatment is called for.

## DEFORMITIES OF THE UPPER EXTREMITY.

**Congenital Absence of the Clavicle.**—Both clavicles may be absent, and although there is no impairment of function, it is possible for the patient voluntarily to bring his shoulders into contact with one another in front of the chest.

**Displacements of the Scapula.**—In the *congenital upward displacement* (Sprengel's shoulder), the one shoulder appears higher than the other, the trapezius is prominent, and the dorsal spine is convex to the affected side. In addition to the upward displacement the scapula may also be tilted so that its inferior angle approaches the spine and its axillary border is nearly horizontal. It is sometimes associated with imperfect development of the lower part of the trapezius, and with a partial arrest of growth of the scapula and clavicle. When abduction is seriously restricted as a result of the posterior superior angle of the bone coming into contact with the transverse processes of the cervical vertebræ, this angle of the bone may be removed.

**Winged Scapula.**—This condition consists in a marked displacement backwards of the lower angle and vertebral border of the scapula, when the patient attempts to raise the arm from the side (Fig. 307). Under normal conditions, in making this movement the serratus magnus and rhomboid muscles pull forward the vertebral border and inferior angle of the scapula, and so fix the bone firmly against the chest wall. When these muscles are paralysed, as a result of infantile paralysis, neuritis, or injury of the nerve of Bell, or of the fifth and sixth cervical nerve roots, through which they receive their supply, the patient is unable to abduct the arm, the deltoid having lost its *point d'appui*, and its contraction merely results in tilting the angle of the scapula backward.

*Treatment.*—In the majority of recent cases the condition yields to the administration of strychnine and other muscle and nerve tonics, and the use of massage and the faradic current. The application of a carefully adjusted padded belt is sometimes useful. The method of treatment by stitching the latissimus dorsi over the lower angle of the scapula is based on the erroneous assumption that the displacement is due to the slipping of that muscle from off the bone; although it must be admitted that the operation sometimes diminishes the deformity and adds to the patient's comfort.

A more efficient method has been proposed and practised by Tubby; it consists in detaching the sternal portion of the

pectoralis major from its tendon of insertion and stitching it to the serratus magnus so as to take on the function of this muscle.

Displacement of the scapula upwards and outwards, has been observed as a result of partial paralysis of the trapezius when the spinal accessory nerve has been divided in removing tuberculous glands from the neck. In these acquired displacements, treatment is directed towards the nerve lesion and towards the improvement of the muscles by electricity, massage, and exercises.

**Congenital Dislocation of the Shoulder.**—This rare condition is usually bilateral and is associated with other congenital defects. The glenoid cavity is deformed or absent altogether, and the dislocation may be subcoracoid, subacromial, or subspinous. The movements of the arm are restricted, and the development of the extremity as a whole is interfered with. The condition is treated on the same lines as congenital dislocation of the hip; reducing the dislocation by manipulation, or, if this fails, by operation.



Fig. 307. — Winged Scapula; the patient is holding the arms out in front.

**Paralytic Deformities. — Paralytic Dislocation of the Shoulder.**—The muscles in the region of the shoulder may have their innervation interfered with as a result of various conditions, of which infantile paralysis and injuries of the brachial plexus at birth are the most important. The capsular ligament of the shoulder-joint being no longer kept tense by the scapular muscles —especially the deltoid and external rotators—becomes relaxed, and is stretched by the weight of the arm. The appearances are characteristic. The muscles of the shoulder are wasted, the acromion is prominent, and between it and the upper end of the humerus there is a marked hollow into which one or more fingers may be inserted. The arm hangs flaccid by the side, rotated inwards and pronated, and moves in a flail-like fashion in all directions, the patient having very little control over it. The best results are obtained by the transplantation of muscles; the

trapezius is detached from the clavicle and is stitched to the surface of the deltoid; the arm is fixed in the position of horizontal abduction with the arm rotated out and supinated. When this method is impracticable, the upper arm may be fixed to the trunk by some form of apparatus, or a close fibrous union between the humerus and glenoid is brought about by operation (arthrodesis), so that the movements of the scapula may be communicated to the upper arm and thus enable the patient to execute purpose-like movements.

In cases of infantile paralysis when all the muscles governing the **elbow** are paralysed, while the muscles of the hand have escaped, it may be of great service to fix the joint permanently at a right angle. This may be effected by arthrodesis, or by the method practised by Jones and Tubby, which consists in removing an extensive diamond-shaped portion of skin from the flexor aspect of the joint and bringing the raw surfaces together.

In spastic paralysis the most pronounced deformity is flexion of the forearm and pronation and flexion of the **hand** (Fig. 278). Gradual extension at the wrist may be brought about by the use of a malleable iron splint, in which the angle is gradually increased, over a period of at least twelve months. Failing success by this method, operation may be had recourse to, and this will consist in tenotomy, lengthening of tendons, and tendon transplantation. Tubby has devised an operation for converting the pronater radii teres into a supinator, and Robert Jones another in which the flexors of the carpus are made to take the place of the extensors. "These operations, combined if necessary with elongation of the flexors of the fingers, pave the way for diminution of the angle of flexion at the elbow, lessening of the pronator spasm, increase of the supinating power, reduction of the carpal flexion, and addition to the extensor power at the wrist" (Tubby and Jones).

**Congenital Dislocations at the Elbow.**—The head of the radius may be dislocated forwards, backwards or outwards—usually in association with imperfect development of the outer condyle of the humerus. As the displaced head of the bone interferes with the movements at the elbow-joint, the best treatment is to excise it. Congenital dislocation of both bones of the forearm is extremely rare.

**Cubitus Valgus and Cubitus Varus.**—When the normal arm hangs by the side with the palm of the hand directed forwards, the forearm and upper arm form an angle which is open outwards—this is known as the "carrying angle"; it is usually more marked in women in association with the greater breadth

of the pelvis. When this angle is exaggerated the attitude is described as one of *cubitus valgus* (Fig. 131). This deformity may be acquired as a result of rickets, but more commonly it is due to a fracture of the external condyle of the humerus, in which the separated fragment has been displaced upwards. Sometimes it is of congenital origin and is associated with great slackness of the ligaments.

*Cubitus varus* (Fig. 130) is the reverse of cubitus valgus. It is more common, and is nearly always a result of fracture of the lower end of the humerus or separation of the epiphysis and subsequent interference with growth. These deformities may be corrected by supra-condylar osteotomy of the humerus.

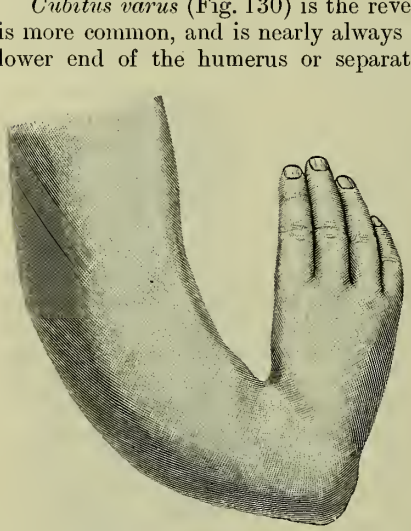


Fig. 308.—Club-hand, the result of imperfect development of radius. The thumb is absent.

(From a cast in Mr. Annandale's collection.)

**Deformities of the Forearm and Hand.**—The *radius* may be absent completely or in part, frequently in combination with other malformations. The most evident result is a deviation of the hand to the radial side—one variety of *club-hand* (manus vara). The forearm is shortened, the ulna is thickened and often bent, the thumb and its metacarpal bone are often absent, and the usefulness of the hand and arm is greatly impaired (Fig. 308). For its treatment Bardenheuer has devised an operation which consists in splitting the lower end of the ulna longitudinally and inserting the proximal bones of the carpus into the cleft. Congenital deficiency of the *ulna* is extremely rare.

A deformity resembling congenital club-hand is brought about when the growth of either of the bones of the forearm has been arrested as a result of disease or of traumatic separation of its lower epiphysis. The hand deviates to the side on which the growth has been arrested. The treatment consists in resecting a portion of the longer bone.

**Dropped Wrist from Infantile Paralysis.**—In this condition

the capacity of extending the fingers may be deficient or absent. If, on still further flexing the fingers, they can be voluntarily extended towards the point from which they are flexed, recovery can be confidently predicted (Tubby and Jones). Considerable improvement may result from fixing the hand in a splint in an attitude of dorsal flexion (hyper-extension) for a period of one to two years. The splint is removed at frequent intervals to allow of massage and other treatment.

**Congenital Contracture of the Wrist—Club-hand Proper.**—This very rare deformity corresponds to congenital club-foot, and probably arises in the same way. The appearances resemble to a certain extent those of paralysis of the musculo-spiral nerve. The hand and fingers are rigidly flexed to the ulnar side, so that the patient is incapable of moving them. Treatment is carried out on the same lines as for club-foot.

**Spontaneous Subluxation of the Wrist.**—This is an acquired



Fig. 309.—Congenital Contraction of Ring and Little Fingers.

deformity, and is met with between the ages of fifteen and twenty-five, chiefly in females who follow trades which entail hard manual labour. The gradual relaxation of ligaments allows the flexors to displace the carpus towards the palm, while the lower ends of the bones of the forearm project on the dorsum. The usefulness of the hand is greatly impaired. The patient must give up her occupation for a time and persevere with a course of massage, electricity, and exercises.

**Congenital dislocation of the wrist** is excessively rare.

**Deformities of the Fingers.**—*Congenital dislocations* of various forms are met with, but are of little clinical importance as they interfere but slightly with the usefulness of the finger affected.

*Congenital lateral deviation of the phalanges* is more unsightly than disabling; it is met with chiefly in the thumb, in which the terminal phalanx may deviate to the radial or to the ulnar side. The deviation disappears on flexion.

*Congenital contraction of the fingers* is comparatively common. It is an inherited deformity, and is often met with in several members of the same family. It most frequently affects the little or the ring and little fingers (Fig. 309). The second and third phalanges are flexed towards the palm; the first phalanx is dorsi-flexed, this being the reverse of what is observed in Dupuytren's contraction. The affection is usually disregarded in infancy and childhood as being of no importance. Its etiology is not known. In the first stage, the deformity is easily corrected by the child wearing a light splint fixed with strips of plaster, or a piece of whalebone or steel inside the finger of a

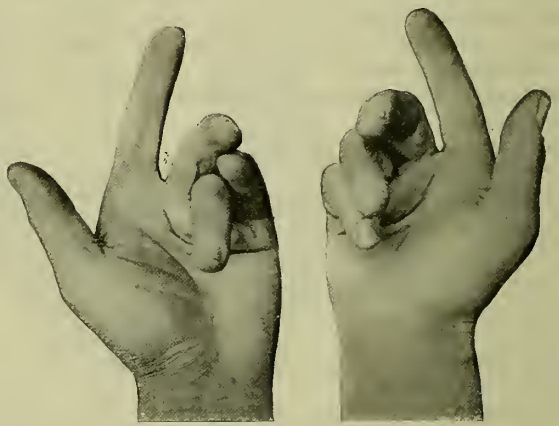


FIG. 310.—Dupuytren's Contraction.

glove. At a later stage, the tense ligaments on the palmar aspect may require to be divided subcutaneously before it is possible to extend the finger. A retentive splint must be worn for a long period, at first night and day, and later during the night only.

**Dupuytren's Contraction.**—This is an acquired deformity resulting from contraction of the palmar fascia and its digital prolongations (Fig. 310). It is rare in childhood and youth, but is common after middle life, especially in men. It is met with chiefly in those who are predisposed to it by inheritance or by gout, and in those who are liable to arthritis deformans. While sometimes seen in the working classes and attributed to the pressure of some hard object on the palm of the hand—such as a hammer or shovel or whip—its greater frequency in those who

do no manual work, and the fact that it is very often bilateral, indicate that the constitutional factor is the most important in its causation.

In the initial stage there is a well-marked induration in the palm opposite the metacarpo-phalangeal joint, and the skin over it is puckered and closely adherent to the underlying fascia. After a variable interval, the finger is gradually and progressively flexed at the metacarpo-phalangeal joint. The ring finger is usually the first to be affected, less often the fifth, although both are commonly involved. It is rarest of all in the index. The flexion may be confined to the metacarpo-phalangeal joint, or the middle and distal phalanges may also be flexed; and as the deformity becomes more pronounced, the nail of the affected finger may come into contact with the skin of the palm. Dissections show that the flexion of the finger is the result of a chronic interstitial overgrowth and subsequent contraction of the palmar fascia and of its prolongations on to the sides of the fingers. The digital processes of the fascia are thickened and shortened and come to stand out like the string of a bow. The adipose tissue in the skin of the palm disappears, and the skin and fascia thus brought into contact become fused with one another. The tendons and their sheaths are not implicated; they are found lying deeply in the concavity of the curve of the flexed digit. The condition is easily diagnosed from the congenital contraction by the fact that in the latter the proximal phalanx is extended or hyper-extended.



FIG. 311.—Splint used after Operation for Dupuytren's Contraction.

*Treatment.*—When seen in the initial stage, contraction may be prevented by passive movements of the finger and by massage of the indurated fascia. When flexion has already occurred, it is most easily corrected by Adam's operation, which consists in multiple subcutaneous division of the contracted fascia in the palm and of its prolongations on to the finger. In addition to dividing the fascia, the tenotomy knife should be used also to separate the skin from the fascia. The finger is then forcibly

extended, and a well-padded splint is secured to the hand and forearm. The skin on the palmar aspect opposite the first interphalangeal joint may give way when the finger is extended; should this occur, the resulting gap may be filled up by a Thiersch graft. The after-treatment consists in massage and passive movements, and a splint (Fig. 311) may be worn at night until there is no longer any tendency to recontraction. Excision of the affected portions of fascia is now accepted as an alternative operation, and is to be preferred because it is not followed by relapse. When the little finger is fully flexed towards the palm, it should be amputated.

**Supernumerary Fingers (Polydactylism).**—These may coexist



Fig. 312.—Supernumerary Thumb.

with supernumerary toes, and the condition is often met with in several members of the same family. The extra finger may be represented by a mere skin appendage the nature of which may only be indicated by the presence of a rudimentary nail, or by a more or less perfectly formed finger. In the majority of cases it should be removed.

**Congenital Deficiencies in the Number of Fingers.**—One or more fingers may be entirely absent, such deficiency being often associated with imperfect development of the radius or ulna, or they may be represented by short rounded stumps, these being usually ascribed to the strangulation of the digits by amniotic bands *in utero*—the so-called intra-uterine amputation.

**Webbing of Fingers (Syndactylism).**—Congenital webbing or fusion of the fingers may be associated with polydactylism or with congenital hypertrophy, and, like other digital deformities, may affect several members of the same family. The degree of fusion ranges from a web of skin joining the fingers to a growing together of all the tissues. The participation of the bones is well shown in skiagrams. The separation of webbed fingers by surgical means must be considered in relation to the conditions present in each individual case. If an operation is decided upon it should be deferred until the age of five or six years. In the simplest cases it is only necessary to divide the web and to unite the cut edges of skin along each finger by sutures, a Thiersch graft being inserted into the angle between the fingers. An operation in which the skin is dissected up in the form of flaps may be required.



FIG. 313.—Congenital Hypertrophy of Thumb and Index-Finger in a child æt 6.

**Congenital Hypertrophy of the Fingers.**—This is a form of local giantism affecting one or more digits, and involving all the tissues equally, or particularly the adipose tissue. The finger is usually of abnormal size at birth and continues to grow more rapidly than the others, and it may also come to deviate from its proper axis. Such a finger should be removed, as it interferes with the use of the other digits.

**Trigger Finger.**—This is an acquired condition in which movement of the finger, either in flexion or extension, is arrested, and is only completed with the assistance of the other hand. The obstacle to movement is usually overcome with a jerk or snap suggesting a resemblance to the trigger of a gun or the blade of a clasp-knife. The commonest cause is a disproportion between the size of the tendon and its sheath, such as may result from a localised thickening of the tendon. Recovery usually takes place under massage and passive movements.

**Drop or Mallet Finger** has been described with injuries of the fingers.



# INDEX.


Abdomen, bullet wounds of, 230
Abdominal aneurysm, 302
  aorta, embolus of, 99
    compression of, 261
Abscess, 51
  acute circumscribed, 51, 53
  of bone, 593
  Brodie's, 593
  chronic, 148
  cold, 148
    of joints, 653
  extra-articular, 709
  formation of, 52
  Hilton's method of opening, 55
  in hip disease, 692
  pointing of, 52
  psoas, 694
  pyæmic, 57, 69, 270, 274
  residual, 150
  multiple, of skin, 360
  stitch, 55
  treatment of, 54
  tuberculous, 148
    peri-articular, 648, 651
    in skin, 364
Acetabulum, fracture of, 513-534
  tuberculous disease of, 685
  wandering, 685, 701
Achillo-bursitis, 400
Achillo-dynia, 391
Acromion process, fracture of, 463
  separation of epiphysis of, 464
Actinomyces, 134
Actinomycosis, 133
Acupuncture in aneurysm, 297
Acute arthritis of infants, 585, 639
  necrosis of bone, 584
  osteomyelitis and periostitis, 583
Adam's operation, for Dupuytren's contraction, 769
  on neck of femur, 699
Adenoma, 186, 201
  malignant, 207
  sebaceous, 371
  of skin, 370
  varieties of, 202
Adrenalin, 244, 265
Adventitious bursæ, 395, 399, 400
Aërobes, 11
Air embolism, 254
  hunger, 264
  infection from, 37
Albert on arthrodesis, 718
  on knock-knee, 734
Aleppo boil, 136
Alexins, 15
Algidity, 28
Alveolar sarcoma, 199
Ambulant splint, 561, 564, 568
  treatment of hip disease, 696
Amputation for acute osteomyelitis, 588
  in aneurysm, 298
  for cellulitis, 59
  in compound dislocation, 438
  in compound fracture, 419
  for gangrene, 99, 102, 104, 107
  Gritti-Stoke's, 103
  for hæmorrhage, 263
  in hip disease, 699
  for injuries of blood-vessels, 251
  in lacerated wounds, 222
  A. G. Miller's, 103
  for neuroma, 340
  neuromata after, 330
  in pyæmia, 71
  for tuberculous disease of joints, 659
  for tumours of bone, 631
Anæmia, ulcers in, 76
Anaërobes, 11
Anæsthesia, 331

Analgesia, 331
Anatomical tubercle, 141
Anatomy. *See* Surgical Anatomy
Anel's operation for aneurysm, 295
Aneurysm, 287. *See also* Individual Arteries
abdominal, 302
amputation in, 298
by anastomosis, 286
Anel's operation for, 295
Antyllus' operation for, 293
aortic, 301, 302
arterio-venous, 299
axillary, 306
of bone, 631
brachial, 307
Brasdor's operation for, 295
carotid, 303
cirsoid, 286
of cœliac axis, 302
compression for, 296
consolidated, 290, 292
differential diagnosis of, 290
diffused, 289, 292, 299
digital, compression in, 296
dissecting, 289
electrolysis in, 297
excision of, 293
false, 289
femoral, 307, 308
flexion in, 296
of forearm and hand, 307
fusiform, 288
gelatin injections in, 298
gluteal, 307
Hunter's operation for, 295
iliac, 307
of individual arteries, 301
inguinal, 307
innominate, 303
intracranial, 305
of leg and foot, 309
ligation of artery for, 295
Macewen's acupuncture for, 297
Matas' operation for, 294
Moore-Corradi method, 297
natural cure of, 291
old operation for, 293
of ophthalmic artery, 305
orbital, 305
pathological, 287
popliteal, 308
pulse in, 290
recurrent pulsation in, 295
Aneurysm, Reid's method, 297
rupture of, 292, 299
sacculated, 288, 289, 290, 299
sciatic, 307
subclavian, 305
suppuration in, 293
thoracic, 301
traumatic, 298, 299
treatment of, 293
true, 289
varicose, 299, 300, 301
Wardrop's operation for, 295
Aneurysmal varix, 299, 300, 305, 307, 308, 309
Angioma, 186, 281
arterial, 286
capillary, 281
cavernous, 286
racemosum venosum, 275
venous, 275
Angio-neurotic œdema, 332
sarcoma, 199
sclerosis, gangrene from, 104
Angler's elbow, 380
Ankle, cellulitis of, 63
diseases of, 713, 715
dislocations of, 573
fractures in region of, 566
injuries in region of, 565
surgical anatomy of, 565, 713
tuberculous disease of, 714
Ankylosis of joints, 636. *See also* Individual Joints
varieties of, 636
Annandale, Thomas, on flat-foot, 751
on fracture of coronoid process, 481
on intubation, 118
on old operation for aneurysm, 294
on suture of nerves, 335
Ante-cubital lymphatic glands, 311
Anterior crural nerve, lesions of, 350
Anthracæmia, 129
Anthrax, 126
varieties of, 127
Anti-cancerous sera, 206
diphtheritic serum, 117
microbic sera, 15
Antiseptics, 10
chemical, 32
internal, 46
selection of, 32
Antiseptol, 33
Anti-streptococcic serum, 59, 69, 107, 116

Anti-tetanic serum, 124
Antitoxic bodies, 15
sera, 15
Antitoxins, 15
Antivenin, 138
Antyllus' operation for aneurysm, 293
Aorta, abdominal compression of, 261
pulsating, 291, 303
Aortic aneurysm, 301, 302
Arborescent lipoma, 392, 666, 668
Aristol, 34
Arrest of hæmorrhage, 258
Arsenic cancer, 371
Arterial angioma, 286
Arteries, anatomy of, 249
catheterisation of, 103
compression of individual, 260
digital compression of, 260
gangrene following ligature of, 100
injuries of, 250, 254
ligation of, for aneurysm, 295
punctured wounds of, 255
temporary ligature of, 260
wounds of, 252
Arteriorraphy, 253, 294
Arterio-venous aneurysm, 299
Arteritis, varieties of, 270
Artery forceps, 261
Arthrectomy, 659. *See also* Individual Joints
Arthritis, 634. *See also* Individual Joints
acute, 640
of infants, 585, 639
chronic rheumatic, 663
deformans, 663
gonorrhœal, 644
mechanical, 663
neuropathic, 670
ossificans, 637
pneumococcal, 643
purulent, 586
rheumatic, 643
rheumatoid, 663
septic, 432
scarlatinal, 642
sicca, 665, 666
traumatic, 663
tuberculous, 654
urica, 661
Arthrodesis, 718
Arthrolysis, 638
Arthropathies, 332
gliomatous, 672
Articular caries, 648
Ascites, chylous, 313
Asepsis, 10
Aseptic fever, 28, 218
Ashby, on scurvy rickets, 616
Askanazy, on dermoids, 208, 210
Asphyxia, traumatic, 248
Astragalo-scaphoid joint, 566
Astragalus, fracture of, 572
dislocation of, 575
resection of, 576
Atheroma, 100, 271
Athetosis, 718
Atrophy of muscle, 384
Auriculo-temporal nerve, neuralgia of, 355
Avulsion of nerves, 354
of tendons, 384
Axilla, cellulitis of, 63
hygroma of, 316
Axillary aneurysm, 306
artery, embolus of, 99
lymphatic glands, 312, 324

Bacilli, 11
aërobic, 11
anaërobic, 11
Bacillus anthracis, 126
coli communis, 20
diphtheriæ, 116
drum-stick, 119
of Ducrey, 160, 161
of glanders, 130
Klebs-Löffler, 116
of malignant œdema, 107
mallei, 130
pyocyaneus, 21
of soft sore, 160, 161
of tetanus, 119
tubercle, 139
typhosus, 21
Back, golfer's, 380
labourer's, 380
Bacteria, in cancer, 204
death of, 14
fevers due to, 65
general characters of, 10
multiplication of, 10, 13
parasitic, 12
pathogenic, properties of, 12
pyogenic, 16, 21
saprophytic, 12
in tumours, 187
virulence of, 12

Bacterial growth, results of, 13
intoxication, 14
life, conditions of, 11
Bacteriological diagnosis, 16
Bacteriology, surgical, 10
Bacterium, 10
Baker's cysts, 674
Balfour, George W., on treatment of anenrysm, 293
Bandage, for closed fist, 504
elastic, 87, 280-297
Heron-Watson's, 87
many-tailed, 513
Martin's rubber, 88
Plaster of Paris, 417
Unna's, 88
Bardeen on burns, 232
Bardenheuer on club-hand, 766
Barker's flushing spoon, 152
Barlow on scurvy-rickets, 616
Bath, calomel vapour, 170
Bazin's disease, 79, 175
Beach on traumatic asphyxia, 248
Bed-sores, 75, 98, 109
acute, 77, 110
chronic, 110
post-operation, 112
pressure, 77
prevention of, 111
Bell, John, on abscess, 54
nerve of, 344
Benign tumours, 187
Bennett, E. H., of Dublin, on fractures and dislocations, 404, 462, 475, 484, 496, 499, 548
Bennett's fracture, 503, 504
Biceps, bursa under, 397
dislocation of long tendon of, 383
rupture of, 381
Bier's venous congestion in pyogenic infectious, 46, 59, 62, 147
in delayed union of fracture, 428
in tuberculous joints, 657
Bigelow, Λ-shaped ligament of, 519, 530
Billroth on sciatica, 353
Biniodide of mercury, 33
Birth palsies, 344
Biskra button, 136
Bites of animals, 222
Black eye, 217
Blank cartridge, wounds by, 228
Blanket stitch, 220
Bleeder's joint, 669
Bleeders, 266
bruises in, 216
Blind boil, 258, 359
Blisters, 356
in bruises, 217
purulent, 59
Blood-clot, healing by, 4
laminated, 269, 289
varieties of, 269, 289
cysts, 212
letting, general, 46
by incisions, 47
local, 46
poisoning, 14
transfusion of, 265
vessels, 249. *See also* Arteries and Veins
bullet wounds of, 229
diseases of, 269
ligation of, 257, 261
repair of, 255
torsion of, 261
tumours of, 281
Bloodless method of operating, 260
Blue-stone, 86
Boil, 129, 131, 358
Aleppo, 136
Delhi, 136
Boiling, sterilisation by, 31
Bone. *See* Individual Bones
abscess of, 593
aneurysm of, 631
angioma of, 625
atrophy of, 402, 579, 619
bacterial diseases of, 582
Brodie's abscess of, 593
bullet wounds of, 228
cancer of, secondary, 631
caries of, 582
cavities in, 592
changes in acute osteomyelitis, 588
in ulcers, 81
chondroma of, 624
circumscribed abscess of, 593
contusions of, 401
cysts of, 633
diseases of, 578
due to staphylococcus aureus, 583
endothelioma, 626
exostoses of, 621
fibroma of, 625
fragility of, in nerve lesions, 619
grafting, 580
gumma of, 608

Bone, hydatid disease of, 610
hypertrophy of, 579
inflammation of, 581, 582
injuries of, 401
leontiasis ossea, 623
lesions in inherited syphilis, 609
lipoma of, 625
lipping of, 664
malacia of, 611
marrow, function of, 579
myeloma of, 625
myxoma of, 625
necrosis of, 582
neuropathic atrophy of, 619
osteoma of, 621, 623
osteomalacia of, 616
osteomyelitis of, 583
osteoporosis of, 581
Paget's disease of, 618
periosteum, function of, 579
periostitis, 581
pulsating hæmatoma of, 631
pyogenic diseases of, 582
regeneration of, 580
repair of, 7, 424
rickety affections of, 613
sarcoma of, 626
sclerosis of, 579, 590
scurvy affecting, 616
surgical anatomy of, 578
staphylococcal diseases of, 583
syphilitic diseases of, 166, 181, 183, 604, 607
transplantation of, 580
trophic diseases of, 611
tuberculous diseases of, 599, 602
tumours of, 621
malignant, 626
metastatic, 631
Röntgen rays in, 629
thyroid of, 632
typhoid, inflammation of, 596
wounds of, 401
bullet, 228
Bonnet's cuirass, 696
Bony ankylosis, 636
Boracic lint, 38
lotion, 33
Bossing of skull, 180
Bow-knee, 736
Bow-leg, 737
Box splint, 561
Brachial aneurysm, 307
artery, embolus of, 99
Brachial artery, compression of, 260
occlusion of, 99
neuralgia, 351
plexus, lesions of, 343
Brain, bullet wounds of, 229
injuries, temperature in, 27
joint affections in lesions of, 673
syphilitic lesions of, 167, 182
Branchial dermoids, 209
Brasdor's operation for aneurysm, 295
Brodie, Sir Benjamin, on hysterical joint affections. 673
Brodie's abscess, 593
Bruises, 216
Bryant's triangle, 517
Bubo, 318
bullet, 159, 325
of soft sores, 161
Buchner on phagocytosis, 15
Bullet bubo, 159
probes, 224
Bullets, dispersion of, 225
localisation of, 224
removal of, 224
Shrapnel, 231
small bone, effects of, 228
varieties of, 227
Bunion, 757
Buried sutures, 219
Burns, 75, 232
classification of, 233
electrical, 239
gangrene from, 96
pathology of, 232
picric acid in, 237
by Röntgen rays, 238
Bursa, prepatellar, 540
semi-membranosus, 541
subcrural, 540
sub-deltoid, 461
Bursæ, adventitious, 395
affections of, 395
affections of individual, 397
diseases of, 395
injuries of, 395
syphilis of, 397
tuberculosis of, 397
tumours of, 397
Bursal hydrops, 396
hygroma, 396
tumour, solid, 396
Bursitis, gonorrhœal, 396
gouty, 396
trade, 395

Bursitis, traumatic, 395
varieties of, 397
Button suture, Lister's, 220
Button-hole stitch, 220

Cachexia, cancerous, 205
in tumours, 188
Caird, F. M., on dislocation of shoulder, 455
Calcaneo-cuboid joint, 566
Calcification in arteries, 271
in tuberculosis, 145
Callosities, 78, 85, 356
Callous ulcers, 76, 81, 86
Callus, absorption of, 429
excess of, 426
formation of, 424
tumours of, 429
Calmette's antivenin, 138
Calomel vapour bath, 170
Cancer, 203
arsenic, 371
cachexia in, 205
causes of, 204
chimney-sweep's, 371
colloid, 208
columnar epithelial, 207
cystic, 208
definition of, 203
degeneration of, 204
encephaloid, 207
*en cuirasse*, 204
glandular, 207
glandular infection in, 204, 207, 208
histology of, 203
of lymphatic glands, 327
medullary, 207
melanotic, 208, 327, 369, 373
paraffin, 371
pigmented, 327
rodent, 208, 363, 369, 371
scirrhus, 208
of skin, 371
spread of, 204
squamous epithelial, 207
ulceration of, 204
varieties of, 207
Cancrum oris, 108
Cantharidis plaster, 47
Capillaries, anatomy of, 41, 250
Capillary angioma, 281
loops, 2
Carbolic acid, 32
gangrene, 32, 97
Carbolic poisoning, 32
Carboluria, 32
Carbuncle, 129, 131, 359
Carcinoma, 203. *See* Cancer
Caries, 582
of articular surfaces, 635, 648
sicca, 582, 655
syphilitic, 605
tuberculous, 648
Carotid aneurysm, 303
artery, compression of, 260
tubercle, 260, 304
Carpal bones, dislocation of, 502
fracture of, 500
ganglion, 213
Carpo-metacarpal dislocations, 502
Carron oil, 237
Carr's splint, 498
Carrying angle, 472, 476, 480, 765
Cartilage, repair of, 7
ulceration of, 635, 648
Cartilaginous ankylosis, 636
Cartridge, blank, wounds by, 228
wads, wounds by, 226
Caseation in tuberculosis, 145
Catalepsy, 123
Catgut, infection by, 55
preparation of, 36
Cathcart, C. W., on bone changes in ulcers, 82
on Colles' fracture, 497
on venereal warts, 370
Cautery, in hæmorrhage, 261
Cavernous angioma, 286
lymphangioma, 316, 317
Cell nests, 207
Cellular tissue, saline infusion into, 265
Cellulitis, 56
in different situations, 59
diffuse, 56
Celluloid thread, 37
Cephalic or Kopf tetanus, 123, 126
Cerebral abscess, 229
palsies of childhood, 718
Cervical lymphatic glands, 311, 320
rib, 306
sympathetic, excision of, for neuralgia, 355
Chalk stones in gouty joints, 662
Championnière, Lucas-, on massage in fracture, 415
Chancre, concealed, 158, 159, 163
erratic, 160

Chancre, extra-genital, 160
hard, 158
excision of, 162
relapsing false indurated, 177
soft, 160
Chancroid, 160
Charcoal poultice, 87
Charcot's disease, 670, 703
Chase, on fracture of carpal bones, 500
Cheadle on scurvy-rickets, 616
Chemical antiseptics, 32
Chemotaxis, 14
Chest, bullet wounds of, 230
Cheyne, Watson-, on the treatment of cancer, 206
on tuberculous diseases of bone, 599
Chiene, John, on Colles' fractnre, 495
on fracture of clavicle, 447
on fracture of humerus, 465
on fracture of metacarpal, 504
on knock-knee, 736
Chiene's test, 517
Chigoe, 137
Chilblain, 96, 357
Chimney-sweep's cancer, 371
Chipault on the treatment of perforating nlcers, 85
Chloroma, 200
Chondroma, 186, 191, 192, 624
malignant, 624
multiple, 624
Chondro-sarcoma, 200, 624
Chopart's joint, 566
Choroiditis, syphilitic, 167, 182
Chronic glanders, 175
rheumatic arthritis, 663
suppuration, 63
Chylorrhœa, 313
Chylo-thorax, 313
Chylous ascites, 313
Chyluria, 316
Cicatrices, affections of, 374
varieties of, 375
Cicatricial contraction, 3
tissne, 3
Cicatrix horns, 369
Circnmflex nerve, 461
lesions of, 344
Circnmscribed neuroma, 339
Cirsoid anenrysm, 286
Cladins' catgut, 36
Clavicle, absence of, 763
dislocations of, 449
Clavicle, dislocations of acromial end, 449
of both ends, 450
of sternal end, 450
fractnres of, 442
separation of epiphysis, 444
Claw-hand, 347, 349
Cloacæ in bone, 589
Clot, external, 255
internal, 255
laminated, 289
Club-foot, varieties of, 739
Club-haud, 766, 767
Coagulation necrosis, 52
Cobb on traumatic asphyxia, 248
Cocci, 11
Coccydynia, 515
Coccygeal sinnses, 208
Coccyx, fracture of, 515
Codman on fracture of carpal bones, 500
Cœliac axis, aneurysm of, 302
Cohnheim, 186
Cold, in inflammation, 47
Coley's fluid, 200
Collapse, 241, 245
Collateral circulation, 256
Colles' fractnre, 494
reversed, 498
unreduced, 498
law, 183
Colloid cancer, 208
Colnmnar epithelioma, 207
Composite odontoma, 195
Componnd dislocation, 437
palmar ganglion, 215, 392
Condylomata, 165, 179, 180
Congenital, absence of mnscles, 384
cystic tumour, 316, 317
dislocation, 440. *See also* Individnal Joints
telangiectasis, 281
Congestion, 41
passive, Bier's, 46, 59, 62, 147
Connective tissue, repair of, 6
Consolidated aneurysm, 290, 292
Contraction, congenital, of fingers, 768
Dupuytren's, 768
Contracture of joints, 636. *See also* Individual Regions
of muscles, 386
paralytic, 332
Contused wounds, 216, 222, 223
Contusions, 216

Contusions, of bone, 401
of hip, 535
of joints, 431
of muscle, 379
of shoulder, 461
Coracoid process, fracture of, 464
separation of epiphysis of, 464
Cornea, syphilitic ulceration of, 182, 183
Corns, 357
Coronoid process, fracture of, 481
Corpora oryzoidea, 675
Corpuscles, pus, 50
Corrosive sublimate, 32
Counter-irritants, 47
Coxa vara, 613, 725
Craniotabes, 180, 613
Crateriform ulcer of Hutchinson, 371
Creolin, 33
Crepitus in fractures, 408, 423
Crile on shock, 243, 244
Croft's splint, 417, 561
Crossed-leg deformity in hip disease, 700
in coxa vara, 727
Croup, 117
Croupous exudate, 42
Crucial ligaments of knee, rupture of, 552
Crutch paralysis, 336
Cubitus valgus, 476, 765
varus, 476, 765
Cupping, dry, 47
wet, 47
Cutaneous neuro-fibroma, 342
Cutis anserina, 24
Cyanosis, traumatic, 248
Cyst, 150, 210
atheromatous, 367
Baker's, 674
blood, 212
of bone, 633
congenital, 316, 317
dentigerous, 194
derma, 208
exudation, 211
ganglionic, 214
hæmorrhagic, 217
hydatid, 211, 390
implantation, 211
of joints, 674
lymph, 212
lymphatic, 217, 316, 317
parasitic, 211
Cyst, retention, 211
sebaceous, 367
serous, 217
varieties of, 211
venous, 277
Cystic adenoma, 202
carcinoma, 208
hygroma of neck, 212
lymphangioma, 316, 317

Dactylitis, 193
syphilitic, 181, 609
tuberculous, 603
Dangerous area in neck, 255
Davies Colley on hallux rigidus, 759
operation for club-foot, 743
Dawson, F. I., on leucocytosis, 22
Deafness, syphilitic, 182, 183
Deformities. *See also* Individual Regions
from acute osteomyelitis, 591
of extremities, 717
of fingers, 767
of foot, 739
of forearm, 766
of hand, 766
of knee, 728
of leg, rickety, 737
paralytic, of hip, 724
of knee, 730
of shoulder, 764
sabre-blade, 181, 183, 609
saddle nose, 179
following tuberculous disease of knee, 712
of upper extremity, 763
Deformity, cross or scissor's-leg, in coxa vara, 727
in hip disease, 700
Volkmann's supra-malleolar, 739
Degeneration of arteries, 271
gelatinous, 649
of nerves, 329
reaction of, 331
Delayed union of fracture, 470
Delhi boil, 136
Delirium in surgical patients, 245
traumatic, 247
tremens, 246, 412
Dentigerous cyst, 194
Depressed fracture, 405, 406
Derma-cysts, 208
Dermoids, 186, 208

Diabetic gangrene, 103
Diapedesis of red corpuscles, 42
Diastasis, 420. *See* Separation of Epiphysis
Diffuse aneurysm, 289, 292, 299
  fibroma, 196
  lipomatosis, 190, 191
  osteoma, 623
  suppuration, 56
Digital compression in aneurysm, 296
  of arteries, 260
Diphtheria, 116
  antitoxin in, 117
  intubation in, 118
Diphtheritic gangrene, 109
Diplococci, 11
Disinfection of hands, 34
  of skin, 35
Dislocation of ankle, 573
  of astragalus, 575
  of carpal bones, 502
  carpo-metacarpal, 502
  of clavicle, 449
  compound, 437
  congenital, 440. *See* Individual Joints
  of elbow, 482, 486
  of fingers, 510
  with fracture, 438
  habitual, 440
  of hip, 529, 534
  in hip disease, 693
  inter-phalangeal, 577
  of joints, 434
  of knee, 545
  medio-tarsal, 576
  of metacarpals, 508
  of metatarsals, 577
  of nerves, 337
  old-standing, 438, 486, 534
  operative treatment of, 437
  of patella, 558
  pathological, 440, 586, 648
  of radio-carpal joint, 501
  radio-ulnar joint, inferior, 500
  of radius, 488
    sub-luxation of head of, 488
  recurrent, 440
  of scapula, 449
  of shoulder, 452
    paralytic, 764
  sub-astragaloid, 576
  tarso-metatarsal, 577
Dislocation, of tendons, 382
  of thumb, 508
  of tibia, total, 548
  of tibio-fibular joint, inferior, 574
    superior, 547, 560
  of toes, 577
  traumatic, 434
  of ulna, 487
  of ulnar nerve, 349
  varieties of, 435
  of wrist-joint, 500, 501
Displacement, in fractures, 406
  of semilunar cartilages, 548, 550, 551
  of scapula, 763
Dissecting aneurysm, 289
Donovan's solution, 173
Double oyanide gauze, 38
Double-inclined plane splint, 529
Dover's powder, 46
Doyen's artery clamps, 261
Drainage tubes, 37
  of wounds, 220
Dressings, surgical, 38
Drill-bone, 388
Drop-finger, 510
  foot, 350
  wrist, 345
    from infantile paralysis, 766
Drunkard's palsy, 336, 345
Dry caries, 582
  gangrene, 93
Duchenne's paralysis, 344
Ducrey's bacillus, 160, 161
Duct papilloma, 201
Dugas' symptom in dislocation of shoulder, 454
Duncan, John, on angiomata, 281
  method of treating fracture of clavicle, 446
  on pain in fracture, 411
  on tuberculous arthritic fever, 650
Duodenum, ulceration of, in burns, 235
Dupuytren on burns, 233
Dupuytren's contraction, 768
  fracture, 567, 574
  splint, 570
Durante on treatment of tuberculosis, 147
Dwarf, rickety, 612
  syphilitic, 183

Eburnation of articular surfaces, 665

Ecchondroses, 664
Ecchymosis, 216
Echinococcus, 211
Ecto-cyst, hydatid, 211
Eczema, varicose, 279
Ehrlich, on immunity, 14
  on leucocytes, 21
Elastic bandage, 280, 297
  stockings, 280
  webbing, 87
Elbow, angler's, 380
  arthritis deformans of, 683
  cellulitis of, 62
  diseases of, 682
  dislocations, congenital, of, 765
    old-standing, 486
    traumatic, 482
  examination of, 473
  injuries in region of, 472
  neuro-arthropathies of, 683
  pyogenic diseases of, 683
  sprain of, 489
  surgical anatomy of, 682
  tennis player's, 380, 489
  tuberculous disease of, 682
Electricity, injuries by, 238
Electrolysis, in aneurysm, 297
  in angiomata, 284, 285, 286, 287
Elephantiasis, 314, 315, 316
  lupus, 363, 366
  nervorum, 340
  neuromatosa, 342
  of scrotum, 365, 367
  varieties of, 364
Ellis' exercises for flat-foot, 753
Emboli, septic, 69
Embolic abscesses, 69
  gangrene, 99
Embolism, 270
  air, 254
  fat, 247
  of individual arteries, 99
Embolus, 270
  malignant, 270
Emigration of leucocytes, 42
Emphysema, in cellulitis, 57
Emprosthotonos, 121
Empyema of joints, 635, 653
Encephaloid cancer, 207
Enchondroma, 624
Endarteritis obliterans, 271
  syphilitic, 167
Endocarditis, septic, in pyæmia, 69
Endocyst, hydatid, 211
Endosteal sarcoma, 627
Endothelioid cells, 144
Endothelioma, 197
  of bone, 626
Eosinophilia, 21
Epicritic sensibility of nerves, 329
Epidermis, repair of, 3
Epiphyses, separation of, 420. *See also* Individual Epiphyses
  in osteomyelitis, 585, 586
  partial, 407
Epiphysial cartilage, function of, 579
    in rickets, 612
  junction, 578
Epiphysiolysis, 585, 586
Epiphysitis, 581
  syphilitic, 180, 661
Epithelial odontoma, 194
  pearls, 207
  tumours, 201
Epithelioma, 207
  lupus, 363
  in scars, 376
  sinus, 632
  of skin, 371
  trade, 371
  varieties of, 207
Epithelium grafting, 90
  repair of, 3, 6
Epitrochlear lymphatic glands, 311
Epulis, 625
Erb's paralysis, 343
Ergot, gangrene from, 104
Erratic chancre, 160
Erysipelas, 113, 587
  facial, 114
  neonatorum, 115
  persistent œdema after, 115
  in puerperal women, 115
  temperature in, 25
  varieties of, 114
Erythema pernio, 357
  nodosum, 587
Escharotics in angiomata, 284
Esmarch's tourniquet, 259
Evaporating lotions, 48
Eve on tumours of jaw, 194
Excision, of aneurysm, 293
  of joints, 659
Exfoliation, 582
Exophthalmos, pulsating, 305
Exostosis, 193
  bursata, 622
  cancellous, 622

Exostosis, cartilaginous, 193, 621
false, 388
ivory, 621
membranous, 621
multiple, 622
spongy, 622
spurious, 664
subungual, 194, 378, 622
varieties of, 621
Explosives, wounds by, 223
Extension by perineal band, 525
vertical, 538
by weight and pulley, 524, 695
External iliac artery, embolus of, 99
popliteal nerve, lesions of, 349
Extra-genital chancre, 160
Extravasation of blood, 257
in contusion, 216
Exudates, varieties of, 42
Exudation cysts, 211
Eye, black, 217
syphilitic lesions of, 166, 172, 181, 182, 185

Facial artery, compression of, 260
erysipelas, 114
nerve paralysis of, 123
Fainting, 241
False joint, 429, 470
neuroma, 338
Farcy, 132
Fascia, contraction of palmar, 768
ossification in, 387
Fat embolism, 247, 412
Fatty hernia, 190
tumours, 150, 189
Fehleisen on organism of erysipelas, 113
Fehling on osteomalacia, 617
Femoral aneurysm, 307, 308
artery, compression of, 260
embolus of, 99
lymphatic glands, 312, 324, 327
Femur, fracture of, in children, 538
of condyles of, 542, 543
of great trochanter of, 527
of head of, 518
just below lesser trochanter, 527
of lower end of, 541
of neck of, 518
of shaft of, 536
of upper end of, 517
Femur, great trochanter, tuberculous disease of, 694
incurvation of neck of, 725
necrosis of, 590, 597
sarcoma of, 627
separation of epiphysis of head, 518
separation of lower epiphysis, 541, 543
Fergusson, Sir Wm., on subclavian aneurysm, 298
Fever, 44
aseptic, 28, 218
due to bacteria, 65
gangrene, after acute, 105
growth, 592
hectic, 67
splenic, 126
Fibro-adenoma, 202
Fibroblasts, 2
Fibroid lupus, 362
recurrent, of Paget, 199, 389
uterine, 197
Fibroma, 195
of bone, 625
recurrent, of Paget, 369
of skin, 369
varieties of, 195
Fibromatosis, diffuse, 196
Fibro-myomata, 197
sarcoma, 199
Fibrous ankylosis, 636
odontoma, 194
union in fracture, 429
Fibula, absence of, 738
fracture of, 564
upper end of, 545
Field dressing, in warfare, 224
Filaria sanguinis hominis, 315, 365
Filarial disease, 315
Finckh, on old-standing dislocation of shoulder, 460
Finger, chancre of, 160
drop, 510, 771
mallet, 510, 771
trigger, 771
Fingers, congenital contraction of, 768
deficiencies, 770
dislocation of, 767
hypertrophy of, 771
deformities of, 767
dislocation of, 510
Dupuytren's contraction of, 768
gouty affections of, 662

Fingers, injuries of, 503
supernumerary, 187, 770
webbed, 187, 770
whitlow of, 59
Finsen light treatment, 147, 364
Firearms, wounds by, 223
First intention, healing by, 3
Fishing-gut, 37
Fistula, 64
congenital, 65
lymphatic, 312
principles of treatment of, 65
varieties of, 65
Flail-joints, 744
Flat pelvis, 614
Flat-foot, 750
adolescent, 750
boot, 754
Ellis' exercises for, 753
paralytic, 755
spasmodic, 755
static, 750
traumatic, 755
varieties of, 750, 756
Floating patella, 552
Fluctuation, 53
Fly-blister, 87
Fœtal residues, 186, 187
Fœtus, parasitic, 210
Follicular odontoma, 194
Fomentations, 48
Foot, cellulitis of, 63
Chinese lady's, 748
club-, varieties of, 739
deformities of, 739
flat-, 750
hollow claw-, 749
injuries in region of, 565
splay-, 750
surgical anatomy of, 565
Footballer's knee, 553
Forci-pressure in hæmorrhage, 261
Forearm, cellulitis of, 62
deformities of, 766
fractures of, 489
injuries of, 472
Formalin, 33
Foulis' tourniquet, 259
Fournier on syphilis, 177
Fracture of acetabulum, 513, 534
of acromion process, 463
of ankle, 566
of astragalus, 572
badly-united, 427
Fracture, Bennett's, of base of metacarpal of thumb, 503, 504
during birth, 402
of both bones of leg, 559
of carpal bones, 500
of clavicle, 442
clinical varieties of, 404
of coccyx, 515
Colles', 494
reversed, 498
unreduced, 498
comminuted, 405
complicated, 405
complications of, 411
compound, 405, 418
amputation in, 419
osteomyelitis in, 598
of coracoid process, 464
of coronoid process, 481
crepitus in, 408
delayed union in, 427
delirium tremens in, 412
depressed, 405, 406
with dislocation, 438
displacements in, 406, 407
without displacement, 406
with distraction, 406
Dupuytren's, 567, 574
fat embolism in, 412
of femur, in children, 538
condyles of, 542, 543
extra-capsular, 526
great trochanter of, 527
head of, 518
inter-condylar, 541, 542
intra-capsular, 519
just below lesser trochanter of, 527
lower end of, 541
neck of, 518
shaft of, 536
supra-condylar, 541, 542
fever in, 411
fibrous union of, 429
of fibula, 545, 564
fissured, 405, 407
of forearm, both bones, 489
forms of violence causing, 403
greenstick, 405, 414, 490, 519
of humerus, anatomical neck of, 468
condyles of, 475, 477
head of, 468
inter-condylar, 474, 477
lower end of, 473

Fracture of humerus, shaft of, 469
supra-condylar, 473, 477
surgical neck of, 464
tuberosities of, 468
upper end of, 464
of iliac spines, 514, 515
of ilium, 514
impacted, 407, 414
incomplete, 405, 407
intra-uterine, 402
of ischium, 515
leg, ambulatory treatment of, 569
both bones of, 559
longitudinal, 406
mal-union of, 427, 492, 563
massage and movement in, 415
of metacarpals, 503
of metatarsals, 573
multiple, 405
by muscular action, 403
oblique, 406, 407, 408
of olecranon process, 478
operative treatment of, 417
of os calcis, 572
separation of posterior tubercle of, 572
with overlapping, 406
with overriding, 406
pain in, 411
of patella, 553
old-standing, 557
pathological, 402, 586, 590, 629
of pelvic girdle as a whole, 511
of pelvis, 511
of phalanges of fingers, 506
of toes, 573
Pott's, 566
converse of, 571
of pubes, 512
radiography in, 409
of radius, head of, 481
lower end of, 494-499
neck of, 482
shaft of, 492
upper end of, 481
reduction of, 413, 414
repair of, 7, 424
retention of, 414
with rotatory displacement, 406
of sacrum, 515
of scaphoid, carpal, 500
of scapula, 462
separation of processes of bone, 405
Fracture, setting of, 413
shock in, 411
simple, 405
clinical features of, 408
prognosis in, 412
treatment of, 413
Smith's, 498
spiral, 406
splints for, 416
spontaneous, 402
sprain, 433
sub-periosteal, 405
of tarsus, 573
of tibia, 564
avulsion of tubercle of, 545
head of, 544
upper end of, 544
transverse, 405
traumatic, 403
treatment of, 413
typical, 404
ulna, lower end of, 500
shaft of, 493
upper end of, 478
ununited, 428, 563
want of union in, 428
Fractures, 402. *See* Individual Bones
Fraenkel's pneumococcus, 21
Fragilitas ossium, 402, 620
Fraser, Sir Thomas R., on antivenin, 138
Friedländer's pneumo-bacillus, 21
Frost-bite, gangrene from, 96
prevention of, 97
Fumigation, mercurial, 170
Fürbringer on disinfection of hands, 35
Furunculus orientalis, 136
Fusiform aneurysm, 288

Galvano puncture in aneurysm, 297
Ganglion, 213
carpal, 213
compound palmar, 215, 392
in region of knee, 214
tarsal, 213
varieties of, 213
Ganglionic neuroma, 338
Gangolphe on hydatids of bone, 610
Gangrene, 93
after acute fevers, 105
acute infective, 106
amputation for, 99, 102, 104, 107
from angio-sclerosis, 104
atheroma in, 100

Gangrene, bacterial varieties of, 106
from burns and scalds, 96
cancrum oris, 108
carbolic, 32, 97
from chemical agents, 97
clinical types of, 93
varieties of, 95
from constriction of vessels, 97
definition of, 93
diabetic, 103
diphtheritic, 109
dry, 93
embolic, 99
from ergot, 104
from frost-bite, 96
hospital, 109
from interference with circulation, 95
following ligation of arteries, 100, 263
line of demarcation in, 94
malignant œdema, 107
moist, 95
noma, 108
phagedæna, 109
from physico-chemical causes, 96
Raynand's disease, 105
senile, 100
after simple fracture, 491
symmetrical, 105
traumatic, 106
white, 99
from whitlow, 61
Gant's operation on femur, 699
Garré on boils, 358
Gasserian ganglion, removal of, 355
Gauze, 38
double-cyanide, 38
iodoform, 38
sterilisation of, 36
sterilised, 38
Gegenbauer on lymph cysts, 212
Gelatin, injection of, in aneurysm, 298
in hæmophylia, 269
Gelatinous degeneration of joints, 649
General tuberculosis, 146
Genu recurvatum, 729
valgum, 732
varum, 736
Giant cells, 2, 144
Giantism, 186
local, 762, 771
Glanders, 130
acute, 131
bacillus of, 130
chronic, 132, 175
Glands, lymphatic. *See* Lymphatic Glands
Glandulæ concatinatæ, 311
Glandular carcinoma, 207
Glioma, 197
Gliomatous arthropathies, 672
Glio-sarcoma, 200
Glover's stitch, 220
Gloves, in surgery, 34, 35
Gluteal aneurysm, 307
Glycogen reaction, 23
Glycosuria in perforating ulcer, 77, 85
Golfer's back, 380
Gonococcal lymphangitis, 314
Gonorrhœal joint lesions, 643
ophthalmia, joint lesions following, 643
rheumatism, 643
teno-synovitis, 392
Gooch's splinting, 416
Gordon's splint, 498
Gout, joint affections in, 661
Gouty bursitis, 396
teno-synovitis, 391
tophi, 662
ulcers, 80
Grafting of bone, 580
of epithelium, 90
of mucous membrane, 92
of nerve, 334
of skin, 88
Granulating surfaces, healing by union of, 5
Granulation, healing by, 5
tissue, formation of, 2
syphilitic, 154
tuberculous, 144
Granulations, 5, 73
Granulomata, infective, 154
Greenstick fracture, 490, 519
Grey powder in syphilis, 184
Griffiths, Joseph, on arthritis ossificans, 637
Gritti-Stokes amputation, 103
Groin, cellulitis of, 63
filarial disease in lymphatics of, 315
glands of, 312
Growing pains, 592

Growth fever, 592
Gumma, 150
of bone, 608
peri-bursal, 660
periosteal, 607
peri-synovial, 660
subcutaneous, 174, 176
syphilitic, 173, 181
Gummatous infiltration, 174, 175
Gunshot wounds, 225, 335

Habitual dislocation, 440, 459, 460
Hæmarthrosis, 431
Hæmatemesis, 258
post-operative, 66
Hæmatoma, 217, 257
of periosteum, 401
pulsating, of bone, 631
Hæmaturia, 258
Hæmophilia, 266
bruises in, 216
Hæmophylic joint, 669
Hæmoptysis, 258
Hæmorrhage, 257
accidental, 258
air-hunger in, 264
arrest of, 258, 261
in individual arteries, 260, 261
arterial, 258
capillary, 258
cautery in, 261
constitutional effects of, 263
digital compression in, 260
external, 257
flexion in, 259
forci-pressure in, 261
hot water in, 262
intermediate, 262
internal, 257
into lateral ventricles, 123
ligature in, 261
natural arrest of, 255
in operations, 259
permanent arrest of, 256
prevention of, 259
primary, 258
reactionary, 262
saline infusions in, 265
secondary, 262
styptics in, 262
temporary arrest of, 256
ligature in, 260
torsion in, 261
tourniquets in, 258, 259, 260
Hæmorrhage from varicose veins, 279
venous, 258
Hæmorrhagic cyst, 217
diathesis, 266
exudate, 42
rickets, 616
Hæmorrhoids, 275
Hair, loss of, by Röntgen rays, 239
syphilitic lesions of, 165
Hallux dolorosus, 759
flexus, 759
rigidus, 759
valgus, 757
varus, 759
Hamilton on fracture of acromion, 463
George, on fracture of patella, 554, 556
Hammer toe, 760
Hand, club-, 766, 767
deformities of, 766
injuries in region of, 494
surgical anatomy of, 494
Handkerchief method of treating fracture of clavicle, 448
Hands, disinfection of, 34
Hard chancre, 158
Hartley-Krause operation, 355
Head on nerve lesions, 328, 331, 332, 333, 347, 348
Head injuries by bullets, 229
Healing by blood-clot, 4
by first intention, 3
by granulation, 5
by primary union, 2
under scab, 4
by second intention, 55
sore, 73
treatment of, 83
ulcer, 80
by union of granulating surfaces, 5
Heart, bullet wounds of, 230
Heat, sterilisation by, 31
in treatment of inflammation, 48
Heberden's nodes, 666
Hectic fever, 67
temperature in, 25
Hemiplegia, syphilitic, 167, 182
Hernia cerebri, 229
fatty, 190
of muscle, 382
Herpes, syphilitic, 162
Hickson, Lieutenant-Colonel, on bullet wounds of bone, 228

Hilton, John, on rest and pain, 75, 82
method of opening abscess, 55
Hip, ankylosis of, 724
arthrectomy of, 698
arthritis deformans of, 700
Charcot's disease of, 703
chronic rheumatism of, 701
contractures of, 724
contusion of, 535
disease, 685
dislocations, congenital, 719
old-standing, 534
varieties of, 529
examination of, 517
excision of, 698
hysterical, 704
injuries in region of, 516
neuro-arthropathies of, 703
paralytic deformities of, 724
pyogenic diseases of, 700
sprain of, 535
surgical anatomy of, 516, 684
Thomas' splint for, 696
tuberculous disease of, 685
abscess formation in, 692
bilateral, 700
deformities following, 699
diagnosis of, 694
dislocation in, 693
stages of, 685
treatment of, 695
Hodgen's splint, 525, 528, 537, 543
Hodgkin's disease, 324, 325
Hoffa on congenital dislocation of hip, 719, 722
on deformities of leg, 739
Hoffman on virus of syphilis, 155
Hollow claw-foot, 749
Hood, Wharton, on fracture of patella, 555
on treatment of fractures, 445
Horns, varieties of, 369
Horse-hair, 37
Horsley, Sir Victor, on injuries of brachial plexus, 343
Hospital gangrene, 109
Housemaid's knee, 395, 399
Humerus, fractures of, 464
fracture of anatomical neck, 468
of condyles, 475, 477
of head, 468
of lower end, 473
of shaft, 469
Humerus, fracture of tuberosities of, 468
ununited, 471
separation of lower epiphysis of, 474, 477
of upper epiphysis of, 466
Hunter's operation for aneurysm, 295
Hutchinson, Jonathan, on diffuse osteoma of skull, 623
on syphilis, 160, 172, 177, 182, 183, 184
Hutchinson's teeth, 182, 183
Hydatid cysts, 211
of bone, 610
of muscle, 390
of spine, 610
thrill, 212
Hydrarthrosis, 432, 634
Hydrocele of neck, 212, 317
Hydrogen peroxide, 33
Hydrophobia, 123, 125
Hydrops, 634
in arthritis deformans, 667
bursal, 396
gonorrhœal, 644
intermittent neuropathic, 673
neuropathic, 673
relapsing, 639
rheumatic, 667
syphilitic, 660
of tendon sheaths, 392
traumatic, 552
tuberculous, 647, 652
Hygroma, 316, 317
bursal, 396
of neck, 212, 317
of tendon sheaths, 392
Hyper-abduction method of reducing dislocation of shoulder, 457
Hyperæmia, 41
Hyperostosis, 579, 590
syphilitic, 607
Hypertrophic pulmonary osteo-arthropathy, 620
Hysteria, 123
Hysterical joint affections, 673

Ice-bags, 48
Ichthyma, syphilitic, 164
Ichthyol, 48
Idiopathic aneurysm, 287
tetanus, 120
Igni-puncture in nævus, 285
Iliac aneurysm, 307

Ilio-femoral ligament, 516
Ilium, fractures of, 514
Immersion, continuous, 58
Immunity, 14
  acquired, 14
  artificial, 15
  natural, 14
  unit of, 16
Imperial drink, 46
Implantation cysts, 211
  of nerves, 335
Incised wounds, 218
    of arteries, 252
Inclined plane splint, 556
Incurvation of neck of femur, 725
Indian puzzle, used for dislocation of thumb, 508
Infantile spinal paralysis, 717
Infection, accidental, 30
  from air, 37
  by blood-stream, 30
  by catgut, 55
  mixed, 13
  prevention of, 31
  of wounds, 29
Infective granulomata, 154
Inferior dental nerve, neuralgia of, 354
Inflamed ulcers, 82, 88
Inflammation, 40
  changes in, 41
  chronic, 49
  clinical aspects of, 42
  constitutional disturbance in, 44
  general principles of treatment in, 45
  leucocytosis in, 21
  nature of, 40
  resolution of, 49
  stages of, 41
  terminations of, 49
Infra-orbital nerve, neuralgia of, 354
Infusion of saline solution, 245, 265
Ingrowing toe-nail, 377
Inguinal aneurysm, 307
  lymphatic glands, 312
Injuries, 216. *See also* Individual Tissues and Regions
  constitutional effects of, 241
  indications for amputation in, 222
Innocent tumours, 187
Innominate aneurysm, 303
Inoculation tubercle, 361
Insects, poisoning by, 137
Instruments, sterilisation of, 35
Intermediate hæmorrhage, 262
Internal popliteal nerve, lesions of, 350
Interstitial keratitis, 182, 183, 184
Intestine, repair of, 8
Intoxication, bacterial, 14
  septic, 65
Intracranial aneurysm, 305
Intra-uterine fracture, 402
Intra-cystic growths, 202
Intubation of larynx, 118
Inunction of mercury, 169, 184
Involucrum, 589
Iodides in syphilis, 171, 176
Iodine, 33
  reaction, 23
Iodism, 176
Iodoform, 33
  gauze, 38
  injection of, 147, 151
  in joint diseases, 656
  poisoning, 34
Iritis, syphilitic, 166, 172, 181, 182, 185
Irrigation, continuous, 58
Irritable ulcers, 82, 88
Irritation, 9
Ischial bursa, 398
Ischias scoliotica, 352
Ischium, fracture of, 515
Izal, 33

Jaws, actinomycosis of, 135
  changes of, in rickets, 613
Jigger, 137
Joints. *See also* Individual Joints
  amputation for diseases of, 659
  ankylosis of, 636
  arthrectomy of, 659
  arthritis deformans of, 663
  bacterial diseases of, 639
  Bier's venous congestion in diseases of, 657
  bleeder's, 669
  bullet wounds of, 225, 228
  Charcot's disease of, 670
  cold abscess of, 653
  constitutional diseases of, 661
  contracture of, 636
  contusions of, 431
  cysts of, 674
  developmental errors of, 639
  diseases of, general, 634
    individual, 679

Joints, dislocations, traumatic, 434
disorganisation of, 635
empyema of, 635, 653
excision of, 659
false, 429, 470
flail, 744
gelatinous degeneration of, 649
gliomatous arthropathies of, 672
gonorrhœal affections of, 643
gouty affections of, 661
hæmophylic, 266, 268, 669
hysterical affections of, 673
impaired mobility of, 636
injuries of, 430
iodoform in diseases of, 656
lesions in acute fevers, 643
loose bodies in, 675
luxation of, 434
mimetic affections of, 673
nerve lesions affecting, 670
osteo-arthritis, 663
pneumococcal infection of, 643
pyæmic affections of, 641
pyogenic diseases of, 639
rheumatic affections of, 662, 663
rigidity of, 636, 651
scarlet fever, infection of, in, 642
sources of strength, 430
spinal diseases affecting, 670
sprains of, 432
starting pains in, 635, 651
surgical anatomy of, 430
syphilitic diseases of, 166, 181, 660
tuberculous diseases of, 645
tumours of, 674
typhoid infection of, 642
white swelling of, 649, 653
wounds of, 432
Jones, Robert, on deformities, 745, 765, 767
on fracture of fifth metatarsal, 573
Jugular lymphatic glands, 311
Jumper's sprain, 380
Justa-minor pelvis, 614
Juxta-epiphysial strain, 422

Keloid, 196, 234, 369, 375
Kennedy, Robert, on lesions of nerves, 344
Keratitis, interstitial in syphilis, 182, 183, 184
Keratoma of nail bed, 369
Klebs-Löffler bacillus, 116
Knee, ankylosis of, 731
Knee, arthritis deformans of, 685
Bleeder's, 713
bow-, 736
cellulitis of, 63
cold abscess of, 708
contracture of, 731
deformities of, 728
paralytic, 730
diseases of, 704
pyogenic, 712
tuberculous, 705
dislocations of, 545
congenital, 728
empyema of, 708
footballer's, 553
housemaid's, 395, 399
ganglion of, 214
genu recurvatum, 729
genu valgum, 732
genu varum, 736
injuries in region of, 539
injuries of semilunar cartilages, 548
internal derangement of, 548
knock-, 732
rupture of crucial ligaments of, 552
sprains of, 552
surgical anatomy of, 539, 704
traumatic hydrops of, 552
tuberculous disease of, 705
clinical types of, 706
deformities following, 712
extra-articular abscess in, 709
white swelling of, 708
Knock-knee, 732
Knot, stay, 296
Kocher, on acute osteomyelitis, 587
artery forceps, 261
method of reducing dislocation of shoulder, 455
on preparation of catgut, 36
on use of gloves, 35
Koch's tuberculin, 655, 657
König on diseases of bone, 599
on diseases of joints, 645, 646, 678, 691, 692
on tumours of bone, 630
Kopf or cephalic tetanus, 123, 126
Krause, on trigeminal neuralgia, 355
Krause-Hartley operation, 355

Labourer's back, 380
Lacerated wounds, 222, 223
Lambkin on treatment of syphilis, 170
Laminated clot, 289

Lane, Arbuthnot, on fracture of acromion, 463
on operative treatment of fracture, 563
on traumatic arthritis, 664
Lange on sciatica, 352
Lannelongne on treatment of tuberculosis, 147
Larynx, syphilis of, 166, 182
Late rickets, 615
Lateral onychia, 377
Lead and opium fomentations, 48
Leber, on chemotaxis, 14
Ledderhose, on ganglion, 214
Leeches, 47
Leedham-Green, method of disinfecting hands, 35
Leg, bow-, 737
congenital deficiencies of, 738
fracture of bones of, 559
injuries of, 539
rickety deformities of, 737
ulcer, 75, 84, 89, 175
grafting of, 91
varicose veins of, 274
Leiter's lead tubes, 48
Leontiasis ossea, 623
Leprosy, 154
Leucocytes, emigration of, 42
varieties of, 21
wandering, 2
Leucocythæmia, 326
Leucocytosis, 21
absence of, 22
in acute abscess, 53
in cellulitis, 57
digestion, 22
in diphtheria, 116
in erysipelas, 114
after hæmorrhage, 22
in inflammation, 21
local, 42
ordinary, 21
physiological, 22
post-operative, 22
in septicæmia, 68
Leucopenia, 22
Lichen, syphilitic, 164
Ligaments, crucial, of knee, rupture of, 552
Ligation of arteries for aneurysm, 295
of blood-vessels, 257, 261
gangrene following, 100
temporary, 260
Ligature, lateral, of veins, 254
celluloid thread, 37
linen thread, 37
sterilisation of, 36, 37
Light treatment of lupus, 364
Lightning stroke, 240
Line of demarcation in gangrene, 94
Linen thread, 37
Lingual dermoids, 209
nerve, neuralgia of, 355
Lint, boracic, 38
Lipoma, 150, 189
arborescent, 392, 666, 668
of bone, 625
diffuse, 190, 191
intra-muscular, 190
multiple, 187, 189
nasi, 371
periosteal, 190
subcutaneous, 189, 190
subserous, 190
subsynovial, 190
symmetrical, 189
Lipomatosis, diffuse, 190, 191
Lipping of bone, 664
Liquor epispasticus, 47
Lister, Lord, on antiseptics, 31, 32
on bloodless method of operating, 259
button sutures, 220
strong solution, 33
Liston's long splint, 524
Little's disease, 718
Local asphyxia, 105
syncope, 105
Lock-jaw, 120
Locomotor ataxia, joint lesions in, 670
Long splint, Liston's, 524
Loose bodies in bursæ, 396
in joints, 675
in tendon sheaths, 393
varieties of, 675
Lorenz, on congenital dislocation of hip, 722
Lotion, biniodide of mercury, 33
boracic acid, 33
carbolic, 32
corrosive sublimate, 32
creolin, 33
evaporating, 48
formalin, 33
izal, 33
lead and opium, 48

Lotion, Lister's strong, 33
lysol, 33
peroxide of hydrogen, 33
sanitas, 33
sublimate alcohol, 35
Lumbago, 385
Lumbar puncture, 124
Lupus, 141
elephantiasis, 315, 363, 366
epithelioma, 363
fibroid, 362
light treatment of, 364
syphilitic, 175
tuberculous, 165, 361
Luxation of joints, 434
Lymph, 310
cysts, 212
scrotum, 316
Lymphadenitis, 57, 318
Lymphadenoma, 321, 325
Lymphangiectasis, 212, 315
Lymphangioma, 212
varieties of, 316
Lymphangio-sarcoma, 199
Lymphangitis, 314
septic, 57
varieties of, 314, 315
Lymphatic cyst, 217, 316, 317
fistula, 312
glands, diseases of, 318
distribution of, 311
functions of, 310
morbid anatomy of, 320
surgical anatomy of, 311
syphilitic diseases of, 325
tuberculosis of, 319
tumours of, 326
œdema, 313
vessels, diseases of, 314
injuries of, 312
Lymphatics, 310
perivascular, 310
Lymphocytosis, 22
Lymphoma, 326
Lymphorrhagia, 312
Lympho-sarcoma, 199, 321, 326
Lynn Thomas' clamp tourniquet, 260
Lyon on leucocytosis, 22
Lysol, 33

M'Burney's hook for dislocation of shoulder, 459
Macewen, Sir Wm., on fracture of patella, 554
Macewen on intubation of larynx, 118
on acupuncture in aneurysm, 297
on knock-knee, 732, 736
method of compressing abdominal aorta, 261
Mackenzie-Davidson's cross-thread localiser, 224
Macrophages, 14
Madura foot, 136
*Main en griffe*, 349
Makins on gunshot injuries of spine, 230
Malacia, of bones, 611
of puberty, 615
Malaria, effect of, on temperature, 26
Malcolm, J. D., on shock, 243
Malignant adenoma, 207
cachexia, 205
neuroma, 339
œdema, 107
pustule, 128
syphilis, 167
tumours, 187
ulcers, 80
Mallein, 132
Mallet finger, 510, 771
Malum senile, 663
Malunion of fracture, 427, 492, 563
Manus vara, 766
Many-tailed bandage, 513
Marie, on hypertrophic pulmonary osteo-arthropathy, 620
Marriage and syphilis, 172
Marrow, function of, 579
in rickets, 612
Martin's rubber bandage, 87
Massage, 58
in contusions, 218
in dislocations, 437
in fractures, 415
in sprains, 433
in ulcers, 83
Mastoid lymphatic glands, 311
Matas' operation for aneurysm, 294
Mayo-Robson, on rupture of crucial ligaments, 552
Mechanical arthritis, 663
Median nerve, 472
lesions of, 346
Medio-tarsal joint, 566
Medullary cancer, 207
tumours of bone, 627
Melæna, 258
Melanotic cancer, 208, 369, 373

Melanotic sarcoma, 200, 373
Melon-seed bodies, 648, 675, 706
Meningitis, basal, 123
  cerebro-spinal, 123
Mercu-lint bib, 170
Mercurial inunction, 169, 184
  plaster, Unna's, 171
Mercury, biniodide of, 33
  fumigation, 170
  intra-muscular injection of, 170
  inunction of, 169, 184
  merco-liut bib, 170
  in syphilis, administration of, 169
Metacarpal, of thumb, Bennett's fracture of, 503, 504
  bones, fracture of, 503, 504
  dislocation of, 508
Metatarsal bones, fracture of, 573
  dislocations of, 577
Metatarsalgia, 756
Metchnikoff on immunity, 14
  on syphilis, 156
Michel's suture clips, 220
Microbes, 10
Micrococci, 11
Micrococcus tetragenus, 21
Micro-organisms, 10
  in tumours, 187
Microphages, 14
Middeldorpf's splint for fracture of humerus, 466
Mikulicz on aseptic technique, 35, 36
  on congenital dislocation of hip, 722
  on iodoform injections in diseases of joints, 657
  on knock-knee, 732
  on tumours of bone, 631
Miller, A. G., amputation at knee, 103
  on reduction of dislocation of shoulder, 456
Miller's, James, flat-foot boot, 754
Mimetic joint affections, 673
Miner's elbow, 395, 397
Mitchell's, A. B., operation for varicose veins, 280
Mixed infection, 13
  syphilitic, 162
  nævus, 283
Mobile semilunar cartilage, 548
Moist gangrene, 95
Moles, 368
  uævoid, 281
Molluscum fibrosum, 196, 342, 369
Moore-Corradi method of treatiug aneurysm, 297
Morbus coxæ, 685
Mortou's disease, 756
Moschcowitz on preparation of catgut, 36
Mosetig-Moorhof on iodoform injections, 147
  on filling of bone cavities, 592
Mother's mark, 281
Mouth, actinomycosis of, 135
Muco-pus, 56
Mucous cysts, 211
  membrane, grafting of, 92
    repair of, 6
    suppuration in, 56
  patches, 165
Muir, Robert, on bacteriology, 126, 140
Multilocular cystic tumours of jaw, 194
Multiple neuromata, 340
  peripheral neuritis, 337
Mummery on shock, 243
Mummification, 93
Muscle, affections of, 379
  atrophy of, 384
  congenital absence of, 385
  contracture of, 386
  contusion of, 218, 379
  diseases of, 384
  heruia of, 382
  hydatid cysts of, 390
  inflammation of, 386
  injuries of, 379
  ossification in, 387
  repair of, 8
  rupture of, 380, 382
  sprain of, 379
  transplantation of, 8
  tuberculosis of, 387
  tumours of, 389
  wasting of, in joint disease, 651
  wounds of, 383
Muscular rheumatism, 385
Musculo-spiral nerve, 473
  implicated in fracture of humerus, 470, 471
  injuries of, 344
  lesions of, 344
Mustard leaves, 47
Mycetoma, 136
Myelitis, syphilitic, 167, 182

Myeloma, 196
of bone, 625
of tendon sheaths, 394
Myoma, 196
Myo-sarcoma, 200
Myositis ossificans, 387
progressive ossifying, 389
varieties of, 386
Myxo-adenoma, 202
Myxoma, 196
of bone, 625
Myxomatous degeneration, 196
Myxo-sarcoma, 200

Nævoid mole, 281
Nævus, 281
electrolysis of, 284
operations for, 284
varieties of, 281
Nail horns, 369
Nails, affections of, 376
ingrowing, 377
injuries of, 376
malignant disease of, 378
onychia, varieties of, 377
regeneration of, 6
syphilitic lesions of, 165
trophic changes in, 376
Nasal bones, syphilitic disease of, 606
Naso-pharyngeal polypus, 625
Natal sore, 136
Natiform skull, 180
Neck, cystic hygroma of, 212, 317
glands of, diseases, 320
hydrocele of, 212, 317
lipomatosis of, 190
painful stiff, 385
Necrosis, acute, 584
of bone, 582
coagulation, 52
quiet, of Paget, 596
without suppuration, 596
syphilitic, 605
Needles, sterilisation of, 37
Needling for aneurysm, 297
in sciatica, 353
Nélaton's bullet probe, 224
line, 517
Neoplasms, 186
Nerve of Bell, 344
Nerves, 328. *See also* Individual Nerves
anatomy of, 328
avulsion of, 354
Nerves, blocking of, 244
bullet wounds of, 335
compression of, 335
contusion of, 218, 331, 335
crushing of, 336
degeneration of, 329
diseases of, 337
dislocation of, 337
effects of division of, 331
grafting, 334
implantation, 335
implicated in scar tissue, 335
individual, surgery of, 343
injuries of, 329
joint affections in lesions of, 670
needling of, 353
operations on, 332
physiology of, 328
reaction of degeneration, 331, 336
regeneration of, 8, 329
stretching of, 83, 85, 353
subcutaneous injuries of, 336
suture of, primary, 333
secondary, 334
tumours of, 338
ulcers in lesions of, 76, 85
Nervous system, syphilitic affections of, 182
Neuralgia, 350
brachial, 351
operations for, 354
sciatic, 351
trigeminal, 353
Neurectomy, 354
Neuritis, ascending, 336
multiple peripheral, varieties of, 337, 338
traumatic, 337
Neuro-arthropathies, 670. *See also* Individual Joints
Neuro-fibromatosis, 196, 340, 369
Neuroma, plexiform, 369
stump, 330
varieties of, 338
Neuropathic atrophy of bone, 619
of muscle, 385
hydrops, 673
osteomalacia, 618
Neuro-retinitis, syphilitic, 167, 182
Nicoladoni on transplantation of tendons, 718
Nitrate of silver, burns by, 232
Nitric acid, burns by, 232
Nodes of bone, 579

Nodes, syphilitic, 604
Heberden's, 666
traumatic, 401
Noma, 108
Non-union of fracture, 426
Nose, mucous polypi of, 196
sebaceous adenoma of, 371
Nussbaum on field dressings, 224

Obturator foramen, dislocation into, 533
nerve, lesions of, 350
Occipital lymphatic glands, 311
Odontoma, 194
varieties of, 194
O'Dwyer on intubation of larynx, 118
Œdema, angio-neurotic, 332
lymphatic, 313
malignant, 107
persistent, 115
solid, 314
Ogston's operation for club-foot, 744
for flat-foot, 754
Old-standing dislocation, 438. *See also* Individual Joints
fractures. *See* Individual Bones
Olecranon bursa, affections of, 397
process, fracture of, 478, 481
separation of epiphysis, 478
Onychia, syphilitic, 165
varieties of, 377
Open method of treating wounds, 39
Operations, hæmorrhage in, 259
during shock, 244
Operations—
for abscess, 54
for Achillo-bursitis, 400
for actinomycosis, 135
for acute osteomyelitis, 588
Adam's, for ankylosis of hip, 699
for aneurysm, 293, 301. *See also* Individual Aneurysms
for aneurysm of bone, 631
for arthrectomy, 659
for arthritis deformans, 668
of arthrolysis, 638
for avulsion of tubercle of tibia, 545
for badly united fracture, 427
for blood-letting, 46
for Brodie's abscess of bone, 595
for callous ulcers, 87
for cancrum oris, 108
for carbuncle, 360
for Charcot's disease, 672
Operations, for closure of sinuses, 64
for club-hand, 766
for coccydynia, 575
for compound dislocations, 438
for compound fractures, 419
for congenital deficiencies of bones of leg, 738
for congenital dislocation of hip, 724
for coxa vara, 727
for deformities of scapula, 763, 765
for delayed union of fracture, 427
for diffuse cellulitis, 58
for dislocation of astragalus, 576
for dislocation of clavicle, 451
for dislocation of shoulder with fracture of humerus, 459
for dislocation of tendons, 383
for dislocation of thumb, 509
for displaced semilunar cartilage, 552
for Dupuytren's contraction, 769
of excision of joints, 659
for filling bone cavities, 592
for fistulæ, 65
for flat-foot, 754
for fracture of both bones of leg, 563
for fracture of clavicle, 448
for fracture of femur, 538
for fracture of olecranon, 480
for fracture of patella, 556
for fracture of surgical neck of humerus, 468
for fractures of lower end of humerus, 477
for fractures in region of knee, 544
for ganglion, 215
for gangrene, 98, 100, 102, 107
Gant's, for ankylosis of hip, 699
for genu recurvatum, 730
for genu valgum, 736
for genu varum, 737
for hallux rigidus, 760
for hallux valgus, 759
for hammer-toe, 762
for infusion of saline solution, 265
for injection of antitoxic sera, 16, 118, 124
for injuries of nerves, 333, 335. *See also* Individual Nerves
for leontiasis ossea, 623
for loose bodies in joints, 675, 677
for lupus, 363
for malignant pustule, 130

Operations, for mal-union of bones of forearm, 492
for mal-union after Pott's fracture, 571
for metatarsalgia, 757
for myeloma of bone, 626
for nævus, 285
for neuromata, 339
for old-standing dislocation of shoulder, 460
for old-standing dislocations, 439
for old-standing dislocations of elbow, 487
for old-standing dislocations of hip, 535
for osteoma, 622
for osteomalacia, 617
for paralytic deformities of knee, 731
for perforating ulcer, 85
for pes calcaneus, 748
for pes equinus, 747
for pyæmia, 71
for pyogenic diseases of hip, 701
for recurrent dislocation of shoulder, 461
for relapsing osteomyelitis, 593
for rickety deformities of leg, 738
for rodent cancer, 373
for rupture of crucial ligaments of knee, 552
for ruptured muscle, 381
for sarcoma of bone, 630
for sciatica, 353
for secondary hæmorrhage, 263
of sequestrectomy, 591
for simple dislocations, 437
for simple fractures, 417
of skin-grafting, 88
for subcalcanean bursitis, 400
for subungual exostosis, 378
for syphilitic disease of bone, 608
for talipes equino-varus, 742, 744
for transplantation of bone, 580
for trifacial neuralgia, 354
for tuberculous abscess, 150
dactylitis, 604
disease of ankle, 715
of bone, 600
of elbow, 683
of hip, 698
of knee, 712
of tendon sheaths, 394
of wrist, 684
Operations, for tuberculous glands, 323
ulcers, 86
for tumours. *See* Individual Tumours
for unreduced Colles' fracture, 498
for ununited fracture, 429
for ununited fracture of humerus, 471
for varicose veins, 280
for webbed fingers, 771
for whitlow, 59
Ophthalmic artery, aneurysm of, 305
Opisthotonos, 121
Orbit, syphilitic disease of, 606
Orbital aneurysm, 305
Orthopædic surgery, 717
Orthotonos, 121
Os calcis, fracture of, 572
separation of posterior tubercle of, 572
tuberculous disease of, 602
Os magnum, dislocation of, 502
Osmic acid in neuralgia, 354
Ossification in muscles, tendons, and fasciæ, 387
Ossifying junction, 578
Osteo-arthritis, 663
syphilitic, 660
Osteo-arthropathy, pulmonary, 620
Osteoblasts, 424
Osteochondritis dissecans, 678
Osteoclast, 427
Osteoid sarcoma, 200
Osteoma, 186, 193, 621
cancellous, 193
compact, 194
diffuse, 623
ivory, 194
multiple, 187
spongy, 193
Osteomalacia, cancerous, 632
varieties of, 616
Osteomyelitis, 581
acute, 583
albuminous, 592
after amputation, 598
bipolar, 583
chronic, 595
in compound fractures, 598
deformities following, 591
gummatous, 605
from infection from soft parts, 597

Osteomyelitis, pneumococcal, 596
due to pyogenic infections other than staphylococcus aureus, 596
relapsing, 593
sequelæ of, 588, 590
serous, 592
simulated by hæmophilia, 268
streptococcal, 596
tuberculous, 601
in typhoid fever, 596
Osteophytes, 579, 664
Osteoporosis, 581
Osteopsathyrosis, 620
Osteosarcoma, 200
Osteotomy, 427. *See* Deformities of Individual Bones
Ostitis, 581
deformans, 618
rarefying, 581
Ovarian dermoids, 209
Ovaries, removal of, for osteomalacia, 617
Oxygen, inhalation of, 264
Ozœna, 181, 607

Pachydermatocele, 342
Pachymeningitis, suppurative, 606
Paci on congenital dislocation of hip, 722
Paget, Sir James, on diabetic gangrene, 104
on quiet necrosis, 596
recurrent fibroid of, 199
Paget's disease of bone, 618
Pain, in fractures, 411
in inflammation, 43
referred, 44, 654
starting, in joint disease, 635, 651
varieties of, 44
Painful stiff-neck, 385
subcutaneous nodules, 339, 369
Palate, syphilitic lesions of, 181, 606
Palmar fascia, Dupuytren's contraction of, 768
ganglion, compound, 215, 392
Papilloma, 201, 202
of skin, 369
varieties of, 201
Papular skin eruption, syphilitic, 164, 179
Paquelin's thermo-cautery, 261, 285
Paraffin cancer, 371
injection of, in depressed scars, 375
Paralysis, infantile, 717
Paralysis, pseudo, of syphilis, 180
spastic, 718
Paralytic contracture, 332. *See also* Individual Joints
Paraplegia, syphilitic, 167, 182
Parasitic bacteria, 12
cysts, 211
fœtus, 210
Parotid abscess in pyæmia, 70
lymphatic glands, 311
tumours, 196
Parotitis, 70
Parrot's nodes, 180
Passive congestion, Bier's, 46, 59, 62
Pasteur's treatment for hydrophobia, 126
Patella, congenital absence of, 728
dislocation of, 558
congenital, 729
floating, 552
fracture of, 553, 557
injuries of, 553
Pathogenic bacteria, 12
Pathological dislocation, 440, 648
fracture, 629
separation of epiphysis, 421
Pelvis, fractures of, 511
injuries of, 511
rickety changes in, 614
Penis, diphtheria of, 118
Perforating ulcer, 77, 85, 332
Peri-lymphangitis, 314
Perineal band, extension with, 525
Periosteal sarcoma, 600, 628
Periosteum, function of, 579
gumma of, 607
in rickets, 612
Periostitis, 581. *See also* Osteomyelitis
acute suppurative, 584
evanescent, of syphilis, 604
gummatous, 605
tuberculous, 599
Peripheral neuritis, 337
Peri-phlebitis, 274
Peronei tendons, dislocation of, 383
Peroxide of hydrogen, 33
Persistent flexion of terminal phalanx, 510
Pes arcuatus, 749
calcaneo-valgus, 749
calcaneo-varus, 749
calcaneus, 739, 748
cavus, 746, 749

Pes equinus, 739, 745
excavatus, 749
planus, 750
valgus, 750
varus, 745
Petit's tourniquet, 259, 263, 294
Petrifying sarcoma, 200
Phagedæna, 109, 160, 163
Phagedænic ulcers, 82, 88
Phagocytes, 14
Phagocytosis, 14
Phalanges of fingers, dislocation of, 510
fracture of, 506
lateral deviation of, 767
persistent flexion of terminal, 510
of toes, fractures of, 573
Phelp's box, 696
operation for club-foot, 743
Phenol, 32
Phimosis, with hard chancre, 163
with soft sores, 161
Phlebitis, 273, 279
varieties of, 273, 274
Phleboliths, 270
Phlegmasia alba dolens, 273
Picric acid in burns, 237
Pigeon-breast, 613
toe, 759
Pistol-shot wounds, 224
splint, 498
Plantaris, rupture of, 382
Plaster of Paris splints, 417
Pleurodynia, 385
Pleurosthotonos, 121
Plexiform neuroma, 342, 369
Pneumo-bacillus, Friedländer's, 21
bacteria, 21
Pneumococcal arthritis, 643
Pneumococcus, 21
Pointing of abscess, 52
Poisoning by carbolic acid, 32
by corrosive sublimate, 33
by insects, 137
by iodoform, 34
by strychnine, 123
Poland, John, on separation of epiphyses, 421, 467, 478, 499, 518, 541
Polydactylism, 770
Polypi, 201
Popliteal aneurysm, 308
artery, embolus of, 95
bursæ, 399
lymphatic glands, 312
Popliteal nerves, injuries of, 349, 350
Poroplastic splints, 416
Port-wine stain, 281
Post-anal dimple, 208
Posterior auricular lymphatic glands, 311
Post-operative hæmatemesis, 66
Post-rectal dermoids, 209
Potato-nose, 371
Pott's fracture, 566
converse of, 571
Poultice, boracic, 38
charcoal, 87
Pre-auricular lymphatic glands, 311
Prepatellar bursa, 399, 540
Prepuce, diphtheria of, 118
Pressure sores, 75, 84
Primary hæmorrhage, 258
syphilis, 157
union of wounds, 2
Probe, bullet, 224, 225
Nélaton's, 224
telephone, 224
Progressive ossifying myositis, 389
Prostration with excitement, 244
Protopathic sensibility of nerves, 329
Proud flesh, 81
Psammoma, 200
Pseudarthrosis, 429, 470
Pseudo-fluctuation, 53
Pseudo-leucæmia, 325
Pseudo-paralysis of syphilis, 180
Psoas abscess, 694
bursa, 398
Psoriasis, syphilitic, 164, 172
Pubes, fractures of, 512
Pubic symphysis, separation of, 511
Pulex penetrans, 137
Pulmonary osteo-arthropathy, 620
Pulsating aorta, 291, 303
exophthalmos, 305
hæmatoma of bone, 631
Punctured wounds, 221
of arteries, 252
Purpura, 268
Purulent blister, 59
Pus, 50
corpuscles, 50
muco-, 56
varieties of, 51
Pustular skin eruption, syphilitic, 164
Pustule, malignant, 128
Pyæmia, 69, 132
abscess in joints in, 69

Pyæmia, temperature in, 26
Pyæmic abscess, 57, 69, 270, 274
Pyogenic bacteria, 16, 21
diseases of bone, 582
of joints, 639. *See also* Individual Joints

Quadriceps extensor femoris, rupture of, 381
Quiet necrosis, 596

Rabies in dog, 125
Rachitis, 611
adolescentium, 615
Radial nerve, lesions of, 346
Radio-carpal joint, dislocation of, 501
Radio-ulnar joint, inferior, dislocation of, 500
Radiogram, 409
Radium, in lupus, 364
Radius, dislocation of, 488
fracture, lower end of, 494
shaft of, 492
upper end of, 481
separation of lower epiphysis of, 499
of upper epiphysis of, 481, 482
subluxation of head of, 488, 501
Radius and ulna, simultaneous separation of lower epiphyses of, 500
Ranula, 317
Rarefying ostitis, 581
Ray fungus, 133
Raynaud's disease, 105
Reaction of degeneration, 331, 336
Reactionary hæmorrhage, 262
Recklinghausen, von, on osteomalacia, 618
disease, 342
Rectal dermoids, 209
Recto-vesical fistula, 65
Rectum, saline infusion by, 265
Recurrent dislocation, 440, 459, 460
fibroid of Paget, 199, 389
Red lotion, 86
corpuscles, diapedesis of, 42
Reduction of dislocations, 436. *See* Individual Dislocations
of fractures, 413. *See* Individual Fractures
Reid's method of treating aneurysm, 297
Relapsing chancre, 177
osteomyelitis, 593
Renton, Crawford, on sciatica, 353
Repair, 2
of blood-vessels, 255
of bone, 7, 424
of cartilage, 7
conditions interfering with, 9
of connective tissue, 6
of epithelium, 6
of individual tissues, 5
after loss of tissue, 4
modifications of, 4
of separated parts, 4
of skin, 6
Residual abscess, 150
Resolution of inflammation, 49
Rest, 9,
Rests, fœtal, 186, 187
Retention cysts, 211
Retro-pharyngeal abscess, 311
lymphatic glands, 311
Reverdin's method of skin-grafting, 90
Rhabdomyoma, 197
Rheumatic arthritis, chronic, 643, 663
bursitis, 396
fever, 587
gout, 663
hydrops, 667
torticollis, 385
Rheumatism, acute, 643
articular, 132
chronic, 662
gonorrhœal, 643
muscular, 385
scarlatinal, 642
Rheumatoid arthritis, 663
Richardson, W. G., on treatment of ulcers, 88
Rickets, 402, 611
bone lesions in, 611
changes in skeleton in, 613
hæmorrhagic, 616
late, 615
scurvy, 616
Rickety coxa vara, 728
dwarf, 612
flat-foot, 756
pelvis, 614
rosary, 612
scoliosis, 613, 615
Ricord on syphilis, 157
Rider's bone, 388
Rifle-bullets, wounds by, 227
Rigidity of joints, 636, 651
Rigor, 24

Risus sardonicus, 120
Ritchie, James, on bacteria, 126, 140
Rivers, on nerve lesions, 328
Rodent cancer, 175, 208, 363, 369, 371
  ulcer, 80
Röntgen rays in aneurysm, 303
  in Bazin's disease, 79
  in bone tumours, 629
  burns by, 238
  in cancer, 206
  in hairy moles, 369
  in injuries of bone, 409
  localisation of bullets by, 224
  in lupus, 364
  in nævus, 282
  in osteoma, 194
  stereoscopic, 224
  in tuberculosis, 148, 152
  in tuberculosis of glands, 322, 324
  ulcers from, 75, 86
Roseola, syphilitic, 164
Roux on syphilis, 156
Rupia, syphilitic, 164
Rupture of aneurysm, 299
  of individual muscles, 380
  of tendons, 380

Sabre-blade deformity of tibia, 181, 183, 609
Sacculated aneurysm, 288, 290, 299
Sacro-iliac disease, 694
Sacrum, fracture of, 515
Saddle-nose deformity, 179
Sahli on acute osteomyelitis, 587
Saline infusions, 245
  in hæmorrhage, 265
Sanitas, 33
Sapræmia, 65
  chronic, 67
  temperature in, 24
Saprophytic bacteria, 12
Sarcoma, 198
  of bone, 626
  endosteal, 627
  of joints, 674
  of lymphatic glands, 327
  melanotic, 373
  periosteal, 600, 628
  of skin, 374
  of synovial membrane, 674
  varieties of, 199
Sarsaparilla in syphilis, 171
Sayre's method of treating fracture of clavicle, 446
Scab, healing under, 4
Scalds, 75, 232
  gangrene from, 96
Scalp, bullet wounds of, 229
Scaphoid, carpal, dislocation of, 502
  fracture of, 500
Scapula, dislocation of, 449
  displacements of, 763
  fractures of, 462
  separation of acromial epiphysis, 464
  separation of coracoid epiphysis, 464
  winged, 763
Scar tissue, 3
Scarlet fever, joint lesions in, 642
Scars. *See* Cicatrices
Schaudinn on virus of syphilis, 155
Schede on congenital dislocation of hip, 722
Schimmelbusch's steriliser, 31
Sciatic aneurysm, 307
  nerve, lesions of, 350
  notch, dislocation into, 532
Sciatica, 351
Scirrhus cancer, 207, 208
Scissors-leg deformity in coxa vara, 727
  in hip disease, 700
Sclavo's serum, 130
Sclerosis of bone, 579, 590
Scoliosis, rickety, 613, 615
  in sciatica, 352
Scorbutic ulcers, 80
Scrofulous disease, 139
Scrotum, elephantiasis of, 367
Sculler's sprain, 489
Scurvy, 216, 402
  rickets, 616
Sebaceous adenoma, 371
  cysts, 367
  horns, 369
Second intention, healing by, 55
Secondary hæmorrhage, 262
  malignant neuroma of Garré, 341
  sutures, 39, 334
  syphilis, 163
Secretory glands, repair of, 8
Semilunar bone, carpal, dislocation of, 502
  cartilages, displacements of, 548, 550, 551
    surgical anatomy of, 548
    torn, 551

Semi-membranosus bursa, 399, 541
Senile gangrene, 100
  osteomalacia, 618
Separated parts, reunion of, 4
Separation of epiphyses, 420. *See also* Individual Bones
Sepsis, 10
Septic emboli, 69
  intoxication, 65
  lymphadenitis, 57
  lymphangitis, 57
Septicæmia, 57, 68, 132
  anti-streptococcic serum in, 69
  temperature in, 25
Sequestrectomy, 591
Sequestrum, amputation, 598
  of bone, 582, 591
  syphilitic, 605
Sero-fibrinous exudate, 42
Serous cyst, 217
  exudate, 42
Serratus magnus muscle, paralysis of, 764
Serum, anti-cancerous, 206
  anti-diphtheritic, 117
  anti-microbic, 15
  anti-streptococcic, 59, 69, 107, 116
  anti-tetanic, 124
  antitoxic, 15, 16
  Sclavo's, for anthrax, 130
Seton, 215
Setting of fracture, 413
Shell, Shrapnel, 231
  wounds, 231
Sherren on nerve lesions, 328, 331, 332, 333, 347, 348
Shock, 241, 242
  delayed, 244
Shoulder, arthritis deformans of, 681
  contusions of, 461
  deformities of, 763, 764
  diseases of, 679
  dislocation of, complicated with fracture, 459
    congenital, 764
    old-standing, 460
    paralytic, 764
    recurrent or habitual, 459, 460
    traumatic, 452
  examination of, 441, 679
  injuries of, 441
  neuro-arthropathies of, 681
  pyogenic diseases of, 681
  sprains of, 461
Shoulder, Sprengel's, 763
  surgical anatomy of, 441, 679
  tuberculous disease of, 679
Shrapnel shell, 231
Silk, sterilisation of, 36
Silkworm gut, 37
Silver wire, 37
Simple fractures, 405
  tumours, 187
Sinus, 63
  coccygeal, 208
  epithelioma, 632
  septic, 64
  tuberculous, 64
  varieties of, 63
Skin, 356
  abscesses of, 360
  actinomycosis of, 135
  dermoids, 208
  grafting, 88, 91
  preparation of, for operation, 35
  repair of, 6
  secondary cancer of, 374
  structure of, 356
  syphilitic lesions of, 164, 168, 171, 172, 175
    ulceration of, 165
  tuberculosis of, 361, 364
  tumours of, 369
Skull, bossing of, 180
  bullet wounds of, 229
  craniotabes of, 180
  diffuse osteoma of, 623
  gutter fracture of, 229
  natiform, 180
  Parrot's nodes, 180
  in rickets, 613
  syphilitic disease of, 605, 606
  unilateral hypertrophy of, 623
Slough, 93
Small round cells, 144
Smith, R. W., on fractures, 475
Smith's fracture of radius, 498
Snake-bites, 137
Snuffles, 178
Soft chancre, 160
Soldau on moles, 369
Sore, 160
  bed-, 75
  healing, 73
  Natal, 136
  pressure, 75, 84
  soft, 160
  toes, 100

Sore, veldt, 360
Spanish windlass, 259
Spas, 663, 669
Spasmodic tic, 353
Spastic paralysis, 718
Spencer-Well's artery forceps, 261
Spina ventosa, 603
Spinal arthropathies, 670
  cord, joint affections in lesions of, 670
    repair of, 8
Spine, bullet wounds of, 230
  changes in rickets, 613
  hydatid disease of, 610
Spirochæta pallida, 155
Spironema pallidum, 155
Splay-foot, 750
Splenic fever, 126
Splint, ambulant, 561, 564, 568
  box, 561
  Carr's, 498
  Croft's, 561
  double-inclined plane, 529
  Dupuytren's, 570
  Gooch, 416
  Gordon's, 498
  Hodgen's, 525, 528, 537, 543
  inclined plane, 556
  Liston's long, 524
  materials, 416
  pistol, 498
  Syme's horse-shoe, 570
  Taylor's, 696
  Thomas' hip, 697
    knee, 710
Splints for fracture, 416
  varieties of, 416
Spores, 11
Sporting-guns, wounds by, 225
Sprain fracture, 433
  of hip, 535
  of joints, 432
  jumper's, 380
  of knee, 552
  of muscle, 379
  sculler's, 489
  of shoulder, 461
  sprinter's, 380
  of wrist, 503
Sprained sinew, 213
Spreading ulcers, 82
Sprengel's shoulder, 763
Sprinter's sprain, 380
Staphylococci, 11, 17
Staphylococcus albus, 18
  aureus, 17
Starch splints, 417
Starting pains in joints, 635, 651
Stasis, 42
Stave of thumb, 505
Stay knot, 296
Steam, sterilisation by, 31
Stereoscopic skiagraphy, 224
Sterilisation, by boiling, 31
  by chemical agents, 32
  of gauze, 36
  of gloves, 35
  by heat, 31
  of instruments, 35
  of silk, 36
  by steam, 31
Sterno-clavicular joint, dislocation of, 450
Sterno-mastoid lymphatic glands, 311
Stevenson, Surgeon-General, on bullet wounds, 229, 230
Stimson on fractures, 523
Stitch abscess, 55
Stitches of coaptation, 219
  of relaxation, 220
  varieties of, 220
Stocking, elastic, 280
Streptococci, 11, 17
Streptococcus erysipelatis, 113
  pyogenes, 18, 56
Streptothrix actinomyces, 133
Strumous disease, 139
Struthers, Sir John, on fracture of acromion, 463
Strychnine poisoning, 123
Student's elbow, 397
Stump neuromata, 330
Styptics, 262
Subacromial bursa, 397
  dislocation of shoulder, 458
Subcalcanean bursa, 400
Subclavian aneurysm, 305
  artery, compression of, 260
Subclavicular dislocation of shoulder, 453, 458
Sub-coracoid dislocation of shoulder, 453, 454
Subcrural bursa, 398, 540
Sub-deltoid bursa, 397, 461
Sub-glenoid dislocation of shoulder, 452, 458
Sublimate alcohol, 35

Sub-luxation of head of radius, 488, 501
spontaneous, of wrist, 767
of thumb, 503
Submaxillary lymphatic glands, 311
Submental lymphatic glands, 311
Subscapular nerves, lesions of, 344
Subscapularis bursa, 397
Sub-spinous dislocation of shoulder, 453, 458
Subungual exostosis, 194, 378, 622
Sulphur grains, 133
Sulphuric acid, burns by, 232
Supernumerary fingers, 187, 770
toes, 762
Suppuration, 50
in aneurysm, 293
chronic, 63
diffuse, 56
in mucous membrane, 56
in wound, 55
Supra-clavicular lymphatic glands, 311
Supra-hyoid lymphatic glands, 311
Supra-orbital nerve, neuralgia of, 354
Supra-scapular nerve, lesions of, 344
Supra-trochlear nerve, neuralgia of, 354
Surgery, definition of, 1
Listerian, 31
pre-Listerian, 30
Surgical anatomy of ankle and foot, 565, 713
of blood-vessels, 249
of bone, 578
of elbow, 472, 682
of epiphyses, 420, 578
of forearm, 472
of hip, 516, 684
of joints, 430
of knee, 539, 704
of lymphatics, 310
of nerves, 328
of semilunar cartilages of knee, 548
of shoulder, 441, 679
of skin, 356
of thoracic duct, 313
of wrist and hand, 494, 683
Surgical bacteriology, 10
Sutton, J. Bland, on odontomata, 194
on horns, 369
Sutures, buried, 219
button, Lister's, 220
celluloid thread, 37
Sutures, clips, Michel's, 220
continuous, 220
interrupted, 220
linen thread, 37
secondary, 39
sterilisation of, 36, 37
varieties of, 220
Syme, James, on aneurysm, 294, 309
on treatment of ulcers, 87
Syme's horse-shoe splint, 570
Symington, Johnson, on fracture of acromion, 463
on knock-knee, 733
Symmetrical gangrene, 105
Sympathetic, cervical operations on, 355
Syncope, 241
Syndactylism, 762, 770
Synostosis, 637
Synovia, 430
Synovial membrane, tumours of, 674
Synovitis, 634
acute serous, 639
chronic serous, 634
simple, 653
intermittent, 639
gonorrhœal, 644
relapsing, 639
septic, 432
syphilitic, 660
Syphilides, 164
Syphilis, 154. *See also* Individual Tissues and Organs
abortion in, 178
acquired, 154, 156
in infants, 185
bones, lesions in, 166, 180, 181, 183, 604
brain, lesions in, 167, 182
of bursæ, 397
caries of bone in, 605
choroiditis in, 167
circumcision in, 185
cirrhosis in, 174
Colles' law, 183
contracture of muscle in, 387
dactylitis in, 181, 609
definition of, 154
Donovan's solution in, 173
epiphysitis of infants, 661
gumma, 173, 181
hemiplegia in, 167, 182
hereditary, latent, 183

Syphilis, hydrops in, 660
incubation of, 157
inherited, 154, 177
bone lesions in, 180
contagiousness of, 183
diagnosis of, 183
facies of, 179
permanent signs of, 183
insontium, 157
intermediate stage of, 172
interstitial keratitis in, 182, 183, 184
iodides in, 171, 176
iritis in, 166, 172, 181, 182, 185
joint lesions in, 166, 181
of larynx, 166, 182
lesions of nails in, 377
lupus, 175
lymphadenitis, 325
lymphangitis, 315
malignant, 167
and marriage, 172
mercury in, 169
methods of administering, 169
mixed infection, 162
of mouth, 165
of mucous membranes, 165, 179
mucous patches, 165
of muscle, 387
neuro-retinitis, 167
onychia in, 165, 377
osteoarthritis, 660
of palate, 181
paraplegia, 167, 182
primary, 157
diagnosis of, 162
lesion of, 154, 157
treatment of, 162
pseudo-paralysis of, 180
reminders, 172
sarsaparilla in, 171
second attacks of, 177
secondary, 163
diagnosis of, 168
eye lesions in, 166
lesions of hair in, 165
of nails in, 165
skin lesions in, 164, 168, 171, 179
treatment of, 168
skin affections in, 179
stages of, 157
synovitis, 660
teeth in, 182, 183
treatment of, in, 169, 172
of tendon sheaths, 394
Syphilis, tertiary, 173
diagnosis of, 176
general manifestations of, 173
lesions of mucous membrane, 175
skin lesions in, 174
treatment of, 176
ulcer, 175, 177
of throat, 165
of tongue, 166
of trachea, 182
ulceration of cornea in, 182, 183
ulcers in, 76, 78, 86, 166, 175, 177
vaccination, 185
virus of, 155
Syphiloma, 175
Syringomyelia, joint lesions in, 681, 672

Tabes dorsalis, joint lesions in, 670
Tænia echinococcus, 211
Tailor's ankle, 400
bottom, 395, 398
Talipes, 739. *See also* Pes
equino-varus, acquired, 744
congenital, 739
Targett on hydatids of bone, 610
Tarsal ganglion, 213
Tarso-metatarsal dislocation, 577
Tarsus, dislocations of, 573
fractures of, 573
tuberculosis of, 602
Tattooing, 375
Tavel on quiet necrosis, 596
Taylor's hip splint, 696
Teeth, Hutchinson's, in syphilis, 182
183
Telephone bullet probe, 224
Temperature, subnormal, 28
in surgical diseases, 23
Temporal artery, compression of, 260
Tenderness, 43
Tendinitis, 387
Tendo Achillis, bursa under, 400
rupture of, 382
Tendon sheaths, affections of, 379
diseases of, 390
hydrops of, 392
syphilitic affections of, 394
tuberculosis of, 392
tumours of, 394
whitlow of, 61
Tendons, affections of, 379. *See also* Individual Tendons
avulsion of, 384
diseases of, 384

Tendons, dislocation of, 382
inflammation of, 387
ossification of, 387
repair of, 7, 380
rupture of, 380
transplantation of, 346, 718
tumours of, 389, 394
wounds of, 383
Tennis-player's elbow, 380, 489
Teno-synovitis, varieties of, 390
Teratoma, 210
Tertiary syphilis, 173
Testis, gumma of, 181
Tetanus, 119
acute, 122
anti-tetanic serum, 124
cephalic or kopf, 123, 126
chronic, 122
fulminating, 122
head, 123, 126
hydrophobicus, 123, 126
idiopathic, 120
neonatorum, 123
trismus, 122
varieties of, 122
Tetany, 123
Thiersch's method of skin-grafting, 90
Thigh, injuries of, 511
Thirst, treatment of, 245
Thomas' flexion test in hip disease, 689
hip splint, 696
knee splint, 710
wrench, 743
Thoracic aneurysm, 301
duct, subcutaneous rupture of, 313
surgical anatomy of, 313
wounds of, 313
Thorax, bullet wounds of, 230
rickety changes in, 613
Thorburn on lesions of nerves, 344
Thrombo-phlebitis, 272
Thrombosis, 269, 279
in inflammation, 42
in veins, 272
Thrombus, 269
mixed, 270
red, 269
white, 269
Thumb, Bennett's fracture of, 503, 504
dislocations of, 508
stave of, 505
sub-luxation of, 503
Thymus extract, 269
Thyroid gland, accessory, 322
Thyroid gland, secondary tumours derived from, 632
Tibia, absence of, 738
fracture of, 564
head of, 544
lower end of, 571
upper end of, 544
sabre-blade deformity of, 181, 183, 609
separation of lower epiphysis of, 571
of upper epiphysis of, 544
total dislocation of, 548
tubercle, avulsion of, 545
Tibialis posticus tendon, dislocation of, 383
Tibio-fibular joint, inferior, dislocation of, 574
superior, dislocation of, 547, 560
Tic, spasmodic, 353
Tizzoni's anti-tetanic serum, 124
Toe-nail, ingrowing, 377
Toes, clawing of, 746
deformities of, 756
dislocations of, 577
gouty affections of, 661
hypertrophy of, 762
supernumerary, 762
syphilitic dactylitis of, 609
tuberculous dactylitis, 601
webbed, 762
whitlow of, 63
Tomato tumour, 370
Tonga bean, 33
Tongue, syphilitic lesions of, 166
Tonsillitis, 117
Tophi, gouty, 662
Torsion of blood-vessels, 261
Torticollis, rheumatic, 385
Tourniquet, emergency, 258
Petit's, 294
varieties of, 258, 259
Toxæmia, 14
Toxins, 13
Trachea, syphilis of, 182
Tracheal tug in aneurysm, 302
Tracheotomy, 118
Trade bursitis, 395
Transfusion of blood, 265
Transplantation of tendons, 346, 718
Traumatic aneurysm, 298, 299
arthritis, 663
asphyxia or cyanosis, 248
bursitis, 395
coxa vara, 728

Traumatic delirium, 247
dislocations, 434
flat-foot, 755
fractures, 403
gangrene, 106
hydrops of knee, 552
neuritis, 337
node, 401
separation of epiphysis, 421
teno-synovitis, 390
tetanus, 119
ulcers, 74, 84
Treatment of wounds, 29
Trendelenburg's operation for flat-foot, 755
of supra-malleolar osteotomy, 755
for varicose veins, 280
Trifacial neuralgia, 353
Trigeminal neuralgia, 353
Trigger finger, 771
Trismus, 122
Trochanteric bursa, 398
Trophic changes in nails, 376
after nerve injuries, 332
diseases of bone, 611
ulcer, 77, 332
Tropical elephantiasis, 365
Trunk neuroma, 339
Tubby, A. H., on deformities, 510, 745, 763, 765, 767
Tubercle, anatomical, 141
bacillus, 139
inoculation, 361
nodule, 144
Tubercles, 144
Tuberculin, Koch's, 655, 657
Tuberculosis, 139. *See also* Individual Tissues and Organs
acquired, 143
age incidence in, 144
bacillus of, 139
of bone, 599
of bursæ, 397
calcification in, 145
caseation in, 145
definition of, 139
general, 146
inherited, 143
of joints, 645
latency of, 145
of lymphatic glands, 319
modes of infection, 141
morbid anatomy of, 144
of muscle, 387
Tuberculosis, open-air treatment of, 146
predisposition to, 142
principles of treatment of, 146
of skin, 361
temperature in, 25
of tendon sheaths, 392
Tuberculous abscess, 148
arthritic fever, 650
dactylitis, 603
disease, definition of, 139
granulation tissue, 144
lupus, 361
lymphangitis, 314
onychia, 377
ulcers, 78, 86
Tubulo-dermoids, 209
Tumor albus, 653
Tumours, 186. *See also* Individual Tumours and Tissues
of bone, 621
cachexia in, 188
of callus, 429
congenital cystic, 316, 317
definition of, 186
epithelial, 201
etiology of, 186
innocent, 187, 189
of joints, 674
of lymphatic glands, 326
malignant, 188, 198
mixed, 198
multiple, 188
of skin, 369
varieties of, 187, 189
Twins, conjoined, 210
Typhoid bacillus, 21
joint lesions in, 642
osteomyelitis in, 596

Ulceration, of cartilage, 635, 648
definition of, 72
Ulcers, 72
ambulatory treatment of, 87
in anæmia, 76
bone changes in, 81
under callosities, 78, 85
callous, 76, 81, 86
cancerous, 204
causes of, 74
classification of, 74
clinical arraugement of, 74
examination of, 72
conditions of, 80

Ulcers, constitutional, 78, 85
crateriform, 371
definition of, 72
duodenal, in burns, 235
epithelioma in, 207
excision of, 87
gouty, 80
healing, 80
ideal form of, 73
due to imperfect circulation, 75, 84
due to imperfect nerve-supply, 76, 85
inflamed, 82, 88
irritable, 82, 88
kidney-shaped, syphilitic, 166
leg, 75, 84, 175
excision of, 89
grafting of, 91
malignant, 80
massage in, 83
nerve-stretching in, 83, 85
perforating, 77, 85, 332
phagedænic, 82, 88
pressure, 75, 84
rodent, 80, 371
from Röntgen rays, 75, 239
scorbutic, 80
skin-grafting in, 88
soft sores, 161
spreading, 82
syphilitic, 76, 78, 86, 165, 175, 177
traumatic, 74, 84
treatment of, 82, 83
trophic, 77, 332
tuberculous, 78, 86
varicose, 76, 279
weak, 76, 80, 86
Ulna, dislocation of, 487
fracture of lower end of, 500
shaft of, 493
upper end of, 478
separation of lower epiphysis of, 500
Ulnar nerve, 472
dislocation of, 349
lesions of, 347
Unit of immunity, 16
Unna on burns, 233
Unna's bandage, 88
mercurial plaster, 171
Un-united fracture, 428, 471
Upper arm, injuries of, 441
Urine in carbolic poisoning, 32
in inflammation, 45
in iodoform poisoning, 34
Uterine fibroids, 197

Vagina, diphtheria of, 118
Varicocele, 275
Varicose aneurysm, 299, 300, 301
dermatitis, 76
eczema, 76, 279
ulcer, 76, 279
veins, 274
in callous ulcer, 76
complications of, 279
hæmorrhage in, 279
operations for, 280
varieties of, 274
Varix, 274
aneurysmal, 299, 300, 305, 307, 308, 309
Veins, anatomy of, 249
entrance of air into, 254
injuries of, 253, 254
lateral ligature of, 254
ligature of, in thrombo-phlebitis, 274
repair of, 256
thrombosis of, 272
varicose, 274
wounds of, 254
Veldt sores, 360
Venereal disease, 157. *See* Syphilis
soft sore, 160
warts, 370
Venesection, 46
Venom of snakes, 138
Venous congestion, Bier's, 147, 641, 657
cysts, 277
hæmorrhage, 258
Verruca, 369
Vertebræ, actinomycosis of, 135
Vertical extension, 538
Vesico-vaginal fistula, 65
Villous papilloma, 201
Virchow on angioma, 275
on chondromata, 193
Virulence of bacteria, 12
Volkmann on caries sicca, 655
on hip disease, 685
on tuberculosis of bone, 599
Volkmann's ischæmic paralysis, 386
supra-malleolar deformity, 739
Vulva, diphtheria of, 118
noma of, 108

Walker, Norman, on lupus, 362

Wandering acetabulum, 685, 701
Want of union in fracture, 470
Wardrop's operation for aneurysm, 295
Wart, 201, 369
  horns, 369
  venereal, 370
Water-glass splints, 417
Waterston, David, on reduction of dislocation of shoulder, 456
Watson-Cheyne on anti-streptococcic serum, 69
  on treatment of cancer, 205
  on tuberculous cervical glands, 323
Watson, Sir Patrick Heron-, on Colles' fracture, 497
  on excision of wrist, 684
Watson, Heron-, bandage, 87
Waxy degeneration, 67
  disease, 182
Weak scars, 375
  ulcers, 76, 80, 86
Weaver's bottom, 395, 398
Webbed fingers, 187
  toes, 762
Weight and pulley extension, 524, 695
Weir-Mitchell treatment in hysterical joint affections, 674
Wens, 367
White gangrene, 99
  swelling of joints, 649, 653
Whitlow, 59, 391
  gangrene from, 61
  at nail fold, 59
  purulent blister, 59
  subcutaneous, 60
  subperiosteal, 62
  of tendon sheaths, 61
  thecal, 61
  of toes, 63
  varieties of, 59
Whitman, Royal, on traumatic coxa vara, 728
Whitman's spring for flat-foot, 754
Winged scapula, 344, 763
Wiseman on tumor albus, 653
Wolfe-Krause skin-grafting, 92
Wood-wool, 38
Wool, 38
  sorter's disease, 128
  wood-, 38
Wounds, 218. *See also* Individual Tissues and Regions
  accidental, 38
  acute suppuration in, 55
  of arteries, 252, 254
  of artery and vein, 254
  bullet, 228
  classes of, 29
  contused, 216, 222, 223
  drainage of, 37, 220
  by electricity, 238
  by explosives, 223, 231
  by firearms, 223
  incised, 218
  infection of, 29
  inflammation in, 45
  irrigation of, 58
  lacerated, 222, 223
  of muscle, 383
  open method of treating, 39
  pistol-shot, 224
  punctured, 221
  shell, 231
  suppuration in, 55
  of tendon, 383
  of thoracic duct, 313
  treatment, 29
  varieties of, 218
Wrenches for club-foot, 743
Wright on traumatic asphyxia, 248
Wrist, congenital contracture of, 767
  diseases of, 683
  dislocations of, 500, 501
    congenital of, 767
  drop-, 345, 470
  examination of, 494
  injuries in region of, 494
  spontaneous subluxation of, 767
  sprain of, 503
  surgical anatomy of, 494, 683
  tuberculous disease of, 683
Wry-neck, rheumatic, 385

Xanthoma, 190
X-legs, 700, 727
X-rays. *See* Röntgen Rays

Young on skin-grafting, 92
Y-shaped ligament of Bigelow, 516, 530

Zittmann's decoction, 171

# YOUNG J. PENTLAND'S PUBLICATIONS

**CONTRIBUTIONS to CLINICAL MEDICINE.** By M'Call Anderson, M.D., Professor of Medicine in the University of Glasgow; Physician, Glasgow Western Infirmary. 8vo, Cloth, pp. xii., 416, with 28 Illustrations. Price 10s. 6d. nett.

**TEXT-BOOK of GENERAL BOTANY.** By Dr. W. J. Behrens. Translation from the Second German Edition. Revised by Patrick Geddes, F.R.S.E., Professor of Botany in the University of Dundee. 8vo, Cloth, pp. viii., 374, with 408 Illustrations, finely engraved on Wood, and 4 Analytical Tables. New Edition. Price 5s.

**THE ELEMENTS OF OPHTHALMOSCOPIC DIAGNOSIS.** For the Use of Students attending Ophthalmic Practice. By George A. Berry, M.B., F.R.C.S.Ed., Ophthalmic Surgeon, Edinburgh Royal Infirmary; Lecturer on Ophthalmology in the University of Edinburgh. Crown 8vo, Cloth, pp. xii., 83. Price 3s. 6d.

**DISEASES of the EYE.** A Practical Treatise for Students of Ophthalmology. By George A. Berry, M.B., F.R.C.S.Ed., Ophthalmic Surgeon, Edinburgh Royal Infirmary; Lecturer on Ophthalmology in the University of Edinburgh. Second Edition, revised and enlarged. 8vo, Cloth, gilt top, pp. xxiv., 728, with 197 Illustrations, including many Coloured Figures. Price 25s.

(*Pentland's Medical Series, Volume Second.*

**MANUAL of PRACTICAL OPHTHALMOLOGY.** By George A. Berry, M.B., F.R.C.S.Ed., Senior Ophthalmic Surgeon, Edinburgh Royal Infirmary; Surgeon, Edinburgh Eye Dispensary; Ophthalmic Surgeon, Royal Hospital for Sick Children; Lecturer on Ophthalmology, University of Edinburgh. Crown 8vo, Cloth, pp. xx., 570, with 223 Illustrations, mostly from Original Drawings. Price 10s. 6d. nett.

(*Pentland's Students' Manuals.*

**THE NATIONAL MEDICAL DICTIONARY.** Including English, French, German, Italian, and Latin Technical Terms used in Medicine and the Collateral Sciences, and a Series of Tables of Useful Data. By John S. Billings, A.M., M.D., LL.D. Harv. and Edin., D.C.L. Oxon., Member of the National Academy of Sciences, Surgeon, U.S.A., etc. In Two Volumes, Imperial 8vo, pp. xlviii., 1530. Price 50s. nett.

**DISEASES of the HEART and THORACIC AORTA.** By Byrom Bramwell, M.D., F.R.C.P.Ed., Lecturer on the Principles and Practice of Medicine, and on Practical Medicine and Medical Diagnosis, in the Extra-Academical School of Medicine, Edinburgh; Physician, Edinburgh Royal Infirmary. Large 8vo, Cloth, pp. xvi., 783. Illustrated with 226 Wood Engravings, and 68 pages of Lithograph Plates, exhibiting 91 Figures,—317 Illustrations in all. Price 25s.

**INTRACRANIAL TUMOURS.** By Byrom Bramwell, M.D., F.R.C.P.Ed., Lecturer on the Principles and Practice of Medicine in the Extra-Academical School of Medicine, Edinburgh; Physician, Edinburgh Royal Infirmary. 8vo, Cloth, pp. xvi., 270, with 116 Illustrations. Price 14s.

**ILLUSTRATIONS of the NERVE TRACTS in the MID** and Hind Brain, and the Cranial Nerves Arising Therefrom. By Alexander Bruce, M.D., F.R.C.P.Ed., Lecturer on Neurology in the School of Medicine; Assistant Physician, Royal Infirmary, Edinburgh. Illustrated with a series of 27 Coloured Plates from Original Drawings, with Descriptive Letterpress, and 27 Engravings throughout the Text. Oblong 4to, Cloth. Price 50s. nett.

**THE PRINCIPLES of TREATMENT, and their APPLICA**tions in Practical Medicine. By J. Mitchell Bruce, M.A., LL.D., M.D., F.R.C.P., Consulting Physician to the Charing Cross Hospital and to the Hospital for Consumption, Brompton. Third Impression. 8vo, Cloth, gilt top, pp. xviii., 614. Price 16s.

(*Pentland's Medical Series, Volume Seventh.*

**DISEASE in CHILDREN:** A MANUAL FOR STUDENTS AND PRACTITIONERS. By JAMES CARMICHAEL, M.D., F.R.C.P.Ed., Physician, Royal Hospital for Sick Children; University Lecturer on Disease in Children, Edinburgh. Crown 8vo, Cloth, pp. xviii., 591. Illustrated with Charts. Price **10s. 6d.**

(*Pentland's Students' Manuals.*

**TUBERCULOUS DISEASE of the BONES and JOINTS.** By W. WATSON CHEYNE, F.R.S., F.R.C.S., Professor of Surgery, King's College, London. 8vo, Cloth, pp. xvi., 374. Illustrated with numerous Wood Engravings throughout the Text. Price **14s.** nett.

**SUPPURATION and SEPTIC DISEASES.** THREE LECTURES DELIVERED AT THE ROYAL COLLEGE OF SURGEONS OF ENGLAND. By W. WATSON CHEYNE, F.R.S., F.R.C.S., Professor of Surgery, King's College, London. 8vo, Cloth, pp. xii., 102, with 4 Illustrations. Price **5s.**

**THE TREATMENT of WOUNDS, ULCERS, and ABSCESSES.** By W. WATSON CHEYNE, F.R.S., F.R.C.S., Professor of Surgery, King's College, London. Second Edition. Crown 8vo, Cloth, pp. xvi., 197. Price **3s. 6d.**

**ATLAS of the DISEASES of the SKIN.** By H. RADCLIFFE CROCKER, M.D., F.R.C.P., Physician to the Department for Diseases of the Skin, University College Hospital, London. In 16 Fasciculi, containing 96 plates, exhibiting 238 Figures in colours from Original Drawings specially prepared for the work, with Descriptive Letterpress. Price **21s.** each nett. Or in Two large handsome Folio Volumes, Half Morocco, gilt tops. Price **£18, 18s.** nett.

**MANUAL OF PRACTICAL ANATOMY.** By D. J. CUNNINGHAM, M.D., F.R.S., Professor of Anatomy, University of Edinburgh. Third Edition. In Two Vols., Crown 8vo, Cloth. Volume First—Upper and Lower Limb; Abdomen. Volume Second—Thorax; Head and Neck. Illustrated with nearly 400 Engravings, many in colours. Price **10s. 6d.** each nett.

(*Pentland's Students' Manuals.*

**TEXT-BOOK OF ANATOMY.** Edited by D. J. CUNNINGHAM, M.D., F.R.S., Professor of Anatomy, University of Edinburgh. Second and thoroughly Revised Edition. In One Volume, Royal 8vo, Cloth, pp. xxxvi., 1388. With 936 Wood Engravings from Original Drawings, many printed in colours. Price **31s. 6d.** nett; or in half leather binding, price **35s.** nett.

ALSO IN FOUR SECTIONS.

*Section I.*—General Embryology; Osteology; Articulations or Joints; The Muscular System. Pp. xxxii., 438. Illustrated with 307 Wood Engravings, many printed in colours, in extra cloth binding. Price **12s. 6d.** nett.

*Section II.*—The Nervous System; Organs of Sense and the Integument. Pp. vi., 344. Illustrated with 234 Wood Engravings, some in colours, in extra cloth binding. Price **10s. 6d.** nett.

*Section III.*—Vascular System; Respiratory System; Digestive System. Pp. viii., 364. Illustrated with 184 Wood Engravings, many printed in colours, in extra cloth binding. Price **10s. 6d.** nett.

*Section IV.*—Urogenital System; Ductless Glands; Surface and Surgical Anatomy. Pp. viii., 259. Illustrated with 139 Wood Engravings, some printed in colours. Second Edition. In extra cloth binding. Price **7s. 6d.** nett.

*** The list of Contributors is as follows:—Professor A. H. YOUNG (Manchester), Dr. ARTHUR ROBINSON (Birmingham), Professor ARTHUR THOMSON (Oxford), Professor D. H. HEPBURN (Cardiff), Dr. HAROLD STILES (Edinburgh), Professor A. M. PATERSON (Liverpool), Professor R. HOWDEN (Newcastle), The late Professor A. BIRMINGHAM (Dublin), Professor A. F. DIXON (Dublin), and the EDITOR.

**HYGIENE AND DISEASES OF WARM CLIMATES,** IN A SERIES OF ARTICLES BY EMINENT AUTHORITIES. Edited by ANDREW DAVIDSON, M.D., F.R.C.P.Ed., late Visiting and Superintending Surgeon, Civil Hospital, and Professor of Chemistry, Royal College, Mauritius; Author of *Geographical Pathology*. Royal 8vo, Cloth, pp. xx., 1016. Illustrated with 7 full-page Plates and 97 Engravings throughout the Text. Price **31s. 6d.**

**GEOGRAPHICAL PATHOLOGY.** An Inquiry into the Geographical Distribution of Infective and Climatic Diseases. By Andrew Davidson, M.D., F.R.C.P.Ed., late Visiting and Superintending Surgeon, Civil Hospital, and Professor of Chemistry, Royal College, Mauritius. Two Vols., Large 8vo, Cloth, pp. xvi., 1008. Illustrated with Maps and Charts. Price 31s. 6d.

**TEXT-BOOK of NERVOUS DISEASES.** By American Authors. Edited by Francis X. Dercum, M.D., Ph.D., Clinical Professor of Nervous Diseases in the Jefferson Medical College of Philadelphia. Royal 8vo, Cloth, pp. 1056, with 341 Engravings in the Text, and 7 Coloured Plates. Price 25s. nett.

**THE TOXIC AMBLYOPIAS:** Their Classification, History, Symptoms, Pathology, and Treatment. By G. E. de Schweinitz, A.M., M.D., Professor of Ophthalmology in the Philadelphia Polyclinic. Large 8vo, Cloth, pp. 238, with 46 Illustrations and 9 Plates. Price 16s. nett.

**THE EDINBURGH MEDICAL JOURNAL.** Edited by Alexis Thomson, M.D., F.R.C.S.Ed., and Harvey Littlejohn, F.R.C.S.Ed. Issued monthly. Price 2s. each part; Subscription 21s. per annum (in advance), post free. For the Colonies and Abroad, 24s. per annum (in advance), post free.

**THE ERASMUS WILSON LECTURES on the PATHOLOGY AND DISEASES OF THE THYROID GLAND.** Delivered before the Royal College of Surgeons of England on February 18th, 20th, and 22nd, 1901. By Walter Edmunds, M.A., M.C. (Cantab.), F.R.C.S. (Eng.), Surgeon to the Tottenham Hospital; Surgeon to Out-Patients Evelina Hospital for Sick Children. 8vo, Cloth, pp. 47, with 24 Illustrations. Price 2s. 6d. nett.

**EXAMINATION QUESTIONS,** Set for the Professional Examinations in Edinburgh University during a period of Ten Years, selected from the Calendars. By W. Ramsay Smith, M.B., C.M., B.Sc., Formerly Demonstrator of Anatomy, Edinburgh

School of Medicine, Minto House; late Senior Assistant to the Professor of Natural History, University of Edinburgh.

NATURAL HISTORY, arranged and annotated. Price 1s. nett.
BOTANY, arranged and annotated. Price 1s. 6d. nett.
CHEMISTRY, answered and annotated. Price 2s. nett.
ANATOMY, answered and annotated. Price 2s. nett.
PHYSIOLOGY, answered and annotated. Price 2s. nett.
MATERIA MEDICA, answered and annotated. Price 2s. nett.
MIDWIFERY AND GYNECOLOGY, answered and annotated. Price 1s. 6d. nett.
SURGERY, answered and annotated. Price 1s. 6d. nett.
PRACTICE OF PHYSIC, answered and annotated. Price 1s. 6d. nett.
MEDICAL JURISPRUDENCE AND PUBLIC HEALTH, answered and annotated. Price 2s. nett.
PATHOLOGY, answered and annotated. Price 1s. 6d. nett.

**THE FUNDUS OCULI, with an OPHTHALMOSCOPIC ATLAS,** ILLUSTRATING ITS PHYSIOLOGICAL AND PATHOLOGICAL CONDITIONS. By W. ADAMS FROST, F.R.C.S., Ophthalmic Surgeon, St. George's Hospital; Surgeon to the Royal Westminster Ophthalmic Hospital, London. In one handsome 4to Volume, extra Cloth, gilt top, with 47 Plates, exhibiting 107 beautifully Coloured Figures and numerous Engravings in the Text. Price £3, 3s. nett.

**DISEASES of the HEART and AORTA.** By G. A. GIBSON, M.D., D.Sc., F.R.C.P.Ed., Physician to the Royal Infirmary; Consulting Physician to the Deaconess Hospital; Lecturer on Medicine at Minto House, and on Clinical Medicine at the Royal Infirmary, Edinburgh. 8vo, Cloth, pp. xxiv., 932, with 210 Illustrations. Price 24s. (*Pentland's Medical Series, Volume Sixth.*

**TEXT-BOOK OF MEDICINE.** By BRITISH TEACHERS. Edited by G. A. GIBSON, M.D., D.Sc., F.R.C.P.Ed., Lecturer on the Principles and Practice of Medicine in the Edinburgh Medical School; Physician, Edinburgh Royal Infirmary. Two Volumes, Royal 8vo, Cloth, pp. xxxvi., 1734, with 122 Illustrations. Price 25s. nett.

*** The list of Contributors is as follows:—J. O. AFFLECK, HENRY ASHBY, A. G. AULD, JOHN ROSE BRADFORD, ALEXANDER BRUCE, J. MITCHELL BRUCE, Sir LAUDER BRUNTON, W. S. COLMAN, G. A. GIBSON, A. LOCKHART GILLESPIE, Sir WILLIAM GOWERS, V. D. HARRIS, HERBERT P. HAWKINS, W. ALLAN JAMIESON, the

late A. A. Kanthack, Claude B. Ker, T. W. P. Lawrence, A. P. Luff, Hector Mackenzie, Patrick Manson, Sidney Martin, Sir John William Moore, F. W. Mott, Thomas Oliver, W. Pasteur, R. W. Philip, S. Risien Russell, William Russell, Ralph Stockman, Frederick Taylor, James Taylor, W. Aldren Turner, W. Hale White, R. T. Williamson, G. E. Cartwright Wood, G. Sims Woodhead.

**THE NERVOUS AFFECTIONS of the HEART.** Being the Morison Lectures delivered before the Royal College of Physicians of Edinburgh in 1902 and 1903. By George Alexander Gibson, M.D., D.Sc., F.R.C.P.Ed., F.R.S.E., Honorary Member of the Medico-Chirurgical Society of Norwich; Honorary Corresponding Member of the Therapeutical Society of Paris; Physician to the Royal Infirmary, and Lecturer on Medicine and Clinical Medicine in the Medical School of the Royal Colleges, Edinburgh; Examiner in Medicine in the University of Oxford. Second Edition. 8vo, Cloth, pp. x., 106, with 35 Illustrations. Price 5s. nett.

**PHYSICAL DIAGNOSIS:** A Guide to Methods of Clinical Investigation. By G. A. Gibson, M.D., D.Sc., F.R.C.P.Ed., Physician, Edinburgh Royal Infirmary; Lecturer on the Principles and Practice of Medicine in the Edinburgh Medical School; and William Russell, M.D., F.R.C.P.Ed., Assistant Physician, Edinburgh Royal Infirmary; Lecturer on Pathology and Morbid Anatomy, School of Medicine, Edinburgh. Third Edition, revised and enlarged. Edited by Francis D. Boyd, C.M.G., M.D., F.R.C.P.Ed., Assistant Physician, Royal Infirmary, Edinburgh. Crown 8vo, Cloth, pp. xx., 448, with 144 Illustrations. Price 9s. nett. (*Pentland's Students' Manuals.*

**HYDATID DISEASE IN ITS CLINICAL ASPECTS.** By James Graham, M.A., M.D., late Demonstrator of Anatomy, Sydney University; Medical Superintendent, Prince Alfred Hospital, Sydney. 8vo, Cloth, gilt top, pp. xii., 204, with 34 full-page Coloured Plates. Price 16s.

**HANDBOOK OF OBSTETRIC NURSING.** By F. W. N. Haultain, M.D., F.R.C.P.Ed., Lecturer on Midwifery and Diseases of Women, School of Medicine; Physician for Diseases

of Women, Deaconess' Hospital; Obstetric and Gynecological Physician to the Royal Dispensary, Edinburgh; and J. Haig Ferguson, M.D., F.R.C.P.Ed., Lecturer on Midwifery and Diseases of Women, School of Medicine and Jubilee Institute for Nurses, Edinburgh. Fifth Edition, revised and enlarged. Crown 8vo, Cloth, pp. xvi., 267. Illustrated with Frontispiece and 37 Wood Engravings. Price 5s.

**HUMAN MONSTROSITIES.** By Barton Cooke Hirst, M.D., Professor of Obstetrics in the University of Pennsylvania; and George A. Piersol, M.D., Professor of Embryology and Histology in the University of Pennsylvania. In 4 Fasciculi, folio size. Illustrated with Engravings and 39 full-page Photographic Plates from Nature. Price 25s. each Fasciculus. *Sold only by Subscription.*

**DISEASES OF THE SKIN:** A Manual for Students and Practitioners. By W. Allan Jamieson, M.D., F.R.C.P.Ed., Extra Physician for Diseases of the Skin, Edinburgh Royal Infirmary; Lecturer on Diseases of the Skin in the University of Edinburgh. Fourth Edition, revised and enlarged. 8vo, Cloth, pp. xx., 660, with 9 Coloured Illustrations. Price 21s.

(*Pentland's Medical Series, Volume First.*

**BOTANY:** A Concise Manual for Students of Medicine and Science. By Alexander Johnstone, F.G.S., Lecturer on Botany, School of Medicine, Edinburgh. Crown 8vo, Cloth, pp. xvi., 260, with 164 Illustrations and a series of Floral Diagrams. Price 6s.

(*Pentland's Students' Manuals.*

**A NEW PRONOUNCING DICTIONARY of MEDICAL TERMS.** By John M. Keating, M.D., Fellow of the College of Physicians of Philadelphia, late Visiting Obstetrician to the Philadelphia Hospital, and Lecturer on Diseases of Women and Children. New impression. Large 8vo, Cloth, pp. 818. Price 7s. 6d. nett.

**CLINICAL GYNÆCOLOGY, MEDICAL and SURGICAL.** By American Authors. Edited by John M. Keating, M.D., LL.D., and Henry C. Coe, M.D., M.R.C.S., Professor of Gynæcology, New York Polyclinic. Two Volumes, Royal 8vo, Cloth extra, gilt tops, pp. xviii., 994. Illustrated with 34 full-page Plates and 377 Engravings in the Text. Price 25s. nett.

**GYNÆCOLOGICAL OPERATIONS,** Exclusive of those Interfering with the Peritoneal Cavity. By Skene Keith, F.R.C.S.Ed. 8vo, Cloth extra, pp. xii., 118. Illustrated with 44 Figures. Price **5s.** nett.

**TEXT-BOOK of ABDOMINAL SURGERY:** A Clinical Manual for Practitioners and Students. By Skene Keith, F.R.C.S.Ed.; assisted by George E. Keith, M.B. 8vo, Cloth, gilt top, pp. xx., 508. Price **16s.**

(*Pentland's Medical Series, Volume Fourth.*

**RENAL GROWTHS:** Their Pathology, Diagnosis, and Treatment. By T. N. Kelynack, M.D. (Vict.), M.R.C.P. (Lond.)., Pathologist, Manchester Royal Infirmary; Demonstrator and Assistant Lecturer in Pathology, Owens College, Manchester. 8vo, Cloth, pp. xvi., 269, with 96 Illustrations. Price **12s. 6d.** nett.

**THE PARASITES of MAN,** and the Diseases which Proceed from them. A Text-Book for Students and Practitioners. By Rudolf Leuckart, late Professor of Zoology and Comparative Anatomy in the University of Leipsic. Translated from the German, with the Co-operation of the Author, by William E. Hoyle, M.A. (Oxon.), M.R.C.S., F.R.S.E., Curator of the Museums, Owens College, Manchester. Natural History of Parasites in General—Systematic Account of the Parasites infesting Man—Protozoa—Cestoda. Large 8vo, Cloth, pp. xxviii., 772. Illustrated with 404 Engravings. Price **31s. 6d.**

**TRAUMATIC INFECTION.** Hunterian Lectures delivered at the Royal College of Surgeons of England. By Charles Barrett Lockwood, F.R.C.S., Hunterian Professor, Royal College of Surgeons of England; Assistant Surgeon to St. Bartholomew's Hospital; Surgeon to the Great Northern Central Hospital, London. Crown 8vo, Cloth, pp. xii., 138. Illustrated with 27 Wood Engravings in the Text. Price **3s.**

**ASEPTIC SURGERY.** By Charles Barrett Lockwood, F.R.C.S. Second Edition. Crown 8vo, Cloth, pp. xvi., 264. Price **4s.**

**THE RADICAL CURE of HERNIA, HYDROCELE, and** VARICOCELE. By Charles Barrett Lockwood, F.R.C.S. Crown 8vo, Cloth, pp. xii., 279, with 23 Illustrations. Price **4s. 6d.**

**DISEASES of the THROAT, NOSE, and EAR.** A Clinical Manual for Students and Practitioners. By P. M'Bride, M.D., F.R.C.P.Ed., Lecturer on the Diseases of the Ear and Throat in the University; Aural Surgeon and Laryngologist, Royal Infirmary, Edinburgh. Third Edition, thoroughly revised and partly re-written. 8vo, Cloth, pp. xviii., 744, with 48 Coloured Illustrations from Original Drawings. Price **25s.**

(*Pentland's Medical Series, Volume Third.*

**ATLAS of VENEREAL DISEASES.** A Series of Illustrations from Original Paintings, with Descriptions of the Varied Lesions, their Differential Diagnosis and Treatment. By P. H. Maclaren, M.D., F.R.C.S.Ed., Surgeon, Edinburgh Royal Infirmary; Formerly Surgeon in Charge of the Lock Wards, Edinburgh Royal Infirmary; Examiner in the Royal College of Surgeons, Edinburgh. In One handsome Royal 4to Volume, Extra Cloth. Price **63s.** nett.

**FUNCTIONAL and ORGANIC DISEASES of the** STOMACH. By Sidney Martin, M.D., F.R.S., F.R.C.P., Physician, University College Hospital; Professor of Pathology, University College, London. 8vo, Cloth, pp. xx., 506. Illustrated with numerous Engravings throughout the Text. Price **16s.**

(*Pentland's Medical Series, Volume Fifth.*

**THE NERVOUS SYSTEM and its DISEASES.** A Practical Treatise on Neurology, for the use of Physicians and Students. By Charles K. Mills, M.D., Professor of Mental Diseases and of Medical Jurisprudence in the University of Pennsylvania; Clinical Professor of Neurology in the Women's Medical College, Penn. 8vo, Cloth, pp. xxx., 1056, with 459 Illustrations. Price **25s.**

**THE NURSING and CARE of the NERVOUS and the** INSANE. By Charles K. Mills, M.D. Crown 8vo, Cloth, pp. 147, with 14 Illustrations. Price **4s. 6d.**

**A SYSTEM OF GENITO-URINARY DISEASES,** SYPHILOLOGY, AND DERMATOLOGY. Edited by PRINCE A. MORROW, M.D. 6 Vols., Large 8vo, of about 550 pages each, fully Illustrated. Price **14s.** per Volume, carriage free.

**MANUAL of BACTERIOLOGY.** By ROBERT MUIR, M.D. F.R.C.P.Ed., Professor of Pathology, University of Glasgow; and JAMES RITCHIE, M.D., B.Sc., Reader in Pathology, University of Oxford. Third Edition, revised and enlarged. Crown 8vo, Cloth, pp. xx., 548, with 150 Illustrations in the Text. Price **12s. 6d.**

(*Pentland's Students' Manuals.*

**PRESCRIBING and TREATMENT** IN THE DISEASES OF INFANTS AND CHILDREN. By PHILIP E. MUSKETT, L.R.C.P. & S.Ed., late Surgeon to the Sydney Hospital; formerly Senior Resident Medical Officer, Sydney Hospital. Third Edition, revised, enlarged, and rearranged. 18mo, pp. xx., 334, in Flexible Leather binding for the pocket. Price **6s. 6d.**

**LEAD POISONING,** IN ITS ACUTE AND CHRONIC FORMS. BEING THE GOULSTONIAN LECTURES DELIVERED AT THE ROYAL COLLEGE OF PHYSICIANS. By THOMAS OLIVER, M.D., F.R.C.P., Physician Royal Infirmary, Newcastle-on-Tyne; Professor of Physiology, University of Durham. 8vo, Cloth, pp. xii., 122, with Coloured Illustrations. Price **10s. 6d.**

**LECTURES on ANGINA PECTORIS and ALLIED** STATES. By WILLIAM OSLER, M.D., F.R.C.P., Professor of Medicine in the Johns Hopkins University, Baltimore. 8vo, Cloth pp. viii., 160. Price **6s.** nett.

**THE SCIENCE and ART of OBSTETRICS.** By THEOPHILUS PARVIN, M.D., LL.D., late Professor of Obstetrics and Diseases of Women and Children in Jefferson Medical College, Philadelphia, and one of the Obstetricians to the Philadelphia Hospital. Third Edition, thoroughly revised. Large 8vo, Cloth, pp. 685, with 269 Wood Engravings, and 2 Coloured Plates. Price **18s.**

**COMPEND of HUMAN ANATOMY,** INCLUDING THE ANATOMY OF THE VISCERA. By SAMUEL O. L. POTTER, M.A., M.D., Cooper Medical College, San Francisco. Seventh Edition, revised and enlarged. Crown 8vo, Cloth, pp. 372, with 138 Engravings; also numerous Tables and 16 full-page Plates. Price 5s. nett.

**TEXT-BOOK of PHYSIOLOGY.** By BRITISH PHYSIOLOGISTS. Edited by E. A. SCHÄFER, F.R.S., Professor of Physiology in the University of Edinburgh. Two Volumes. Vol. I., Royal 8vo, Cloth, pp. xx., 1036, with 3 Plates and 93 Illustrations in the Text. Price 31s. 6d. Vol. II., pp. xxiv., 1365, with 449 Illustrations in the Text. Price 42s.

*** The list of Contributors is as follows:—Professor Sir BURDON SANDERSON (Oxford), Professor GAMGEE, Dr. GASKELL (Cambridge), Professor GOTCH (Oxford), Professor SHERRINGTON (Liverpool), Professor M'KENDRICK (Glasgow), Professor HALLIBURTON (King's College), Professor HAYCRAFT (Cardiff), Dr. PEMBREY (Guy's), Professor STARLING (University College), W. H. R. RIVERS (Cambridge), J. N. LANGLEY (Cambridge), Professor WAYMOUTH REID (Dundee), B. MOORE (Charing Cross), F. G. HOPKINS (Cambridge), LEONARD HILL (London Hospital), J. S. EDKINS (St. Bartholomew's), A. A. GRAY (Glasgow), D. NOEL PATON (Edinburgh), and the EDITOR.

**ILLUSTRATIONS of ZOOLOGY,** INVERTEBRATES AND VERTEBRATES. By WILLIAM RAMSAY SMITH, M.B., B.Sc., and J. STEWART NORWELL, B.Sc. New and Cheaper Edition. Crown 4to, extra Cloth, gilt top, with 70 Plates, exhibiting over 400 Figures. Price 7s. 6d.

**PRACTICAL GUIDE to the EXAMINATION of the EYE.** FOR STUDENTS AND JUNIOR PRACTITIONERS. By SIMEON SNELL, F.R.C.S.Ed., Ophthalmic Surgeon, Sheffield General Infirmary. Crown 8vo, Cloth, pp. xvi., 177, with 88 Illustrations. Price 5s.

**LECTURES on GIDDINESS and on HYSTERIA in the MALE.** By Sir THOMAS GRAINGER STEWART, M.D., LL.D., late Physician-in-Ordinary to Her Majesty the Queen for Scotland,

and Professor of the Practice of Physic and of Clinical Medicine in the University of Edinburgh. Crown 8vo, Cloth, pp. x., 89, with 13 Illustrations. Price **2s. 6d.** nett.

**EPIDEMIC OPHTHALMIA:** Its Symptoms, Diagnosis, and Management. By Sydney Stephenson, F.R.C.S.Ed., Ophthalmic Surgeon, Evelina Hospital and N. E. Hospital for Children, London. 8vo, Cloth, pp. xvi., 278. Illustrated with a Coloured Plate and 25 Figures in the Text. Price **9s.** nett.

**APPENDICITIS and PERITYPHLITIS.** By Charles Talamon, Physician to the Tenon Hospital, Paris. Translated from the French by Richard J. A. Berry, M.B., C.M., late President of the Royal Medical Society, Edinburgh. Crown 8vo, Cloth, pp. viii., 239. Price **6s.**

**THE PATHOLOGY and TREATMENT of VENEREAL DISEASES.** By Robert W. Taylor, M.D., Clinical Professor of Venereal Diseases at the College of Physicians and Surgeons (Columbia College), New York; Surgeon to Bellevue Hospital; and Consulting Surgeon to the City (Charity) Hospital, New York. Royal 8vo, Cloth, pp. 1002. Illustrated with 230 Engravings in the Text, and 7 Coloured Plates. Price **22s.** nett.

**OUTLINES of ZOOLOGY.** By J. Arthur Thomson, M.A., Regius Professor of Natural History in the University of Aberdeen. Fourth Edition, revised and enlarged. Crown 8vo, Cloth, pp. xx., 856, with 378 Illustrations in the Text. Price **12s. 6d.** nett. (*Pentland's Students' Manuals.*

**MANUAL of SURGERY.** By Alexis Thomson, M.D., F.R.C.S.Ed., Assistant Surgeon, Edinburgh Royal Infirmary; Surgeon to the Deaconess' Hospital, Edinburgh; and Alexander Miles, M.D., F.R.C.S.Ed., Assistant Surgeon, Edinburgh Royal Infirmary; Surgeon to Leith Hospital. Two Volumes. Crown 8vo, Cloth, pp. xxxvi., 1486, with 418 Wood Engravings. Price **21s.** nett.

Vol. I. General Surgery. Vol. II. Regional Surgery.

(*Pentland's Students' Manuals.*

**PRACTICAL GUIDE to MEAT INSPECTION.** By THOMAS WALLEY, M.R.C.V.S., formerly Principal of the Edinburgh Royal (Dick) Veterinary College; Professor of Veterinary Medicine and Surgery, etc. Fourth Edition, rewritten and enlarged by STEWART STOCKMAN, M.R.C.V.S., Professor of Pathology; Lecturer on Hygiene and Meat Inspection, Edinburgh Royal (Dick's) Veterinary College. Post 8vo, Cloth, pp. xvi., 296, with 14 Coloured Plates and 79 Illustrations in the Text. Price **10s. 6d.** nett.

**DISEASES of the LIVER, GALL BLADDER, and** BILIARY SYSTEM: THEIR PATHOLOGY, DIAGNOSIS, AND SURGICAL TREATMENT. By H. J. WARING, M.S., B.Sc., F.R.C.S., Assistant Surgeon and Lecturer on Surgical Anatomy at St. Bartholomew's Hospital; Surgeon to the Metropolitan Hospital, London. 8vo, Cloth, pp. xvi., 386, with 58 Illustrations. Price **12s. 6d.** nett.

**MANUAL of OPERATIVE SURGERY.** By H. J. WARING, M.S., B.Sc., F.R.C.S., Assistant Surgeon, Lecturer on Surgical Anatomy, and Demonstrator of Practical Surgery, St. Bartholomew's Hospital; Consulting Surgeon to the Metropolitan Hospital, London; Member of Board of Examiners, Royal College of Surgeons, England. Second Edition. Crown 8vo, Cloth, pp. xxx., 659, with 472 Illustrations in the Text.

(*Pentland's Students' Manuals.*

**ECTOPIC PREGNANCY.** By J. CLARENCE WEBSTER, M.D., F.R.C.P.Ed., Professor of Midwifery and Diseases of Women in the University of Chicago; formerly Assistant to the Professor of Midwifery and Diseases of Women, University of Edinburgh. 8vo, Cloth, pp. xvi., 240, with 22 pages of Plates and Figures throughout the Text. Price **12s. 6d.** nett.

**RESEARCHES in FEMALE PELVIC ANATOMY.** By J. CLARENCE WEBSTER, B.A., M.D., F.R.C.P.Ed. Demy 4to, Cloth. Illustrated with 26 full-page Coloured Plates from Original Drawings. Price **30s.** nett.

**TUBO-PERITONEAL ECTOPIC GESTATION.** By J. Clarence Webster, B.A., M.D., F.R.C.P.Ed. Demy 4to, Cloth. Illustrated with 11 full-page Plates, several Coloured, exhibiting numerous Figures. Price **16s.** nett.

**PRACTICAL and OPERATIVE GYNECOLOGY.** By J. Clarence Webster, M.D., F.R.C.P.Ed. Crown 8vo, Cloth, pp. xvi., 296, with 54 Illustrations. Price **7s. 6d.**

(*Pentland's Students' Manuals.*

**DISEASES of WOMEN.** A Text-Book for Students and Practitioners. By J. Clarence Webster, B.A., M.D., F.R.C.P.Ed. Crown 8vo, Cloth, pp. xxiv., 688, with 241 Illustrations. Price **14s.** (*Pentland's Students' Manuals.*

**TEXT-BOOK OF PHARMACOLOGY AND THERAPEUTICS.** Edited by W. Hale White, M.D., F.R.C.P., Physician and Lecturer on Medicine, Guy's Hospital, London. Royal 8vo, pp. x., 1040. Price **21s.** nett.

*** The list of Contributors is as follows:—John Rose Bradford, J. H. Bryant, J. T. Cash, A. R. Cushny, Walter Dixon, Michael G. Foster, A. E. Garrod, J. S. Haldane, Hobart Amory Hare, Leonard Hill, F. G. Hopkins, D. J. Leech, Edward W. Lucas, Hector Mackenzie, C. R. Marshall, Sidney Martin, Thomas Oliver, M. S. Pembrey, G. V. Poore, George Rowell, G. H. Savage, J. V. Shoemaker, Samuel E. Solly, Walter George Smith, Ralph Stockman, Nestor Tirard, J. W. Washbourn, W. Hale White, R. B. Wild.

**DIABETES MELLITUS:** And its Treatment. By Richard T. Williamson, M.D., M.R.C.P., M.R.C.S., Medical Registrar, Manchester Royal Infirmary; Hon. Medical Officer, Pendleton Dispensary; Assistant to the Professor of Medicine, Owens College, Manchester. 8vo, Cloth, pp. xvi., 417, with 18 Illustrations (two coloured). Price **12s. 6d.** nett.

**PRACTICAL PATHOLOGY.** A Manual for Students and Practitioners. By G. Sims Woodhead, M.D., F.R.C.P.Ed., Professor of Pathology in the University of Cambridge; formerly

Director of the Laboratories of the Royal Colleges of Physicians (London) and Surgeons (England). Fourth Edition, 8vo. with Coloured Illustrations, mostly from Original Drawings. *In Press.*

**THE JOURNAL of PATHOLOGY and BACTERIOLOGY.**

Edited, with the collaboration of distinguished British and Foreign Pathologists, by GERMAN SIMS WOODHEAD, M.D., Professor of Pathology in the University of Cambridge. Assisted in special departments by ALLAN MACFADYEN, M.D.; SIDNEY MARTIN, M.D. Lond. (*Pathological Chemistry*); G. E. CARTWRIGHT WOOD, M.D. Edin. (*Bacteriology*); S. G. SHATTOCK, F.R.C.S. (*Morbid Anatomy and Histology*). Issued at Quarterly Intervals. Subscription 21s. per Volume (in advance), post free. Volumes I. to X., in extra cloth binding, price 25s. each nett.

YOUNG J. PENTLAND,

EDINBURGH: 11 TEVIOT PLACE.

LONDON: 38 WEST SMITHFIELD, E.C.